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THE ELECTRICAL REVIEW

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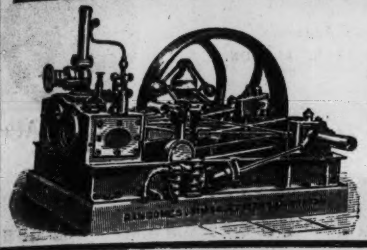

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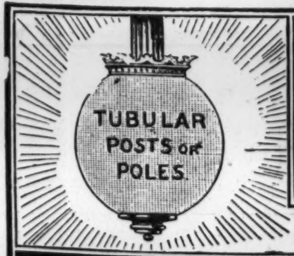

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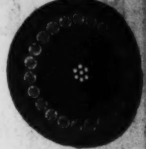

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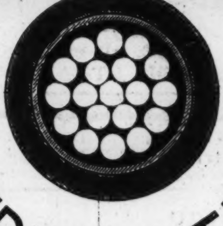

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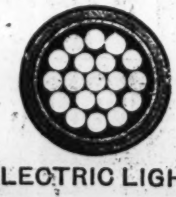

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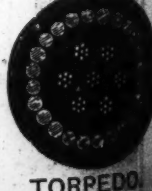

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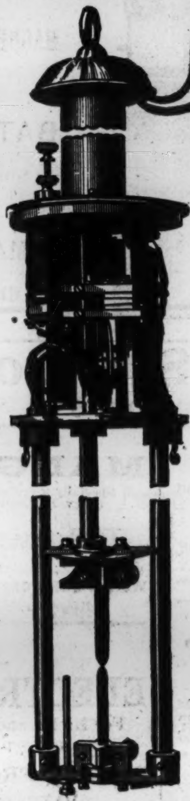

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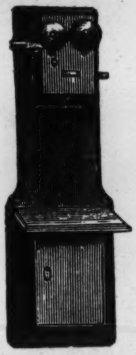

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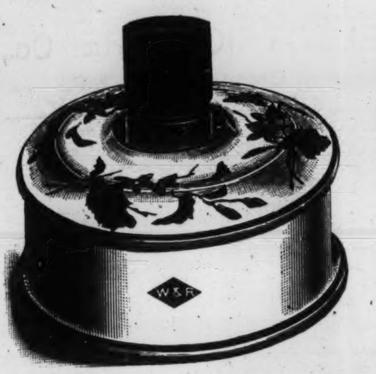

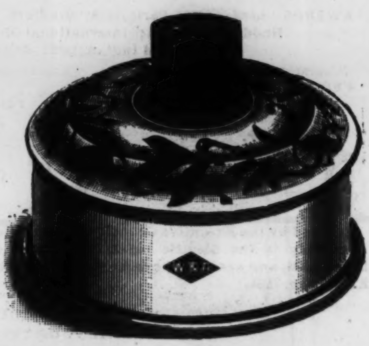

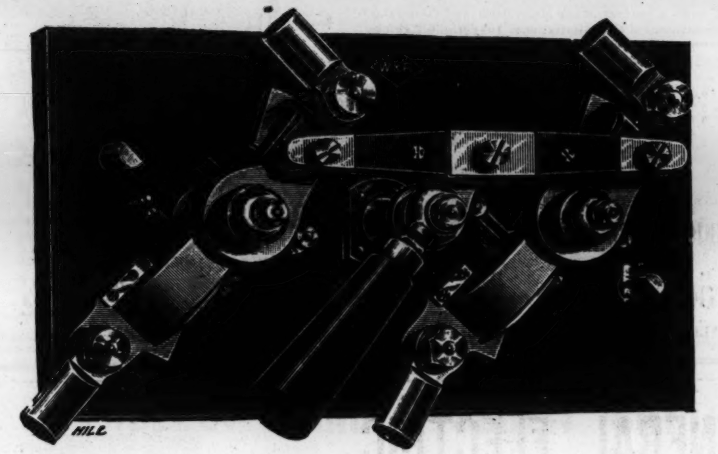

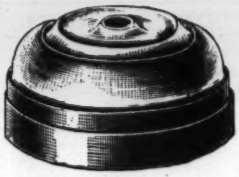

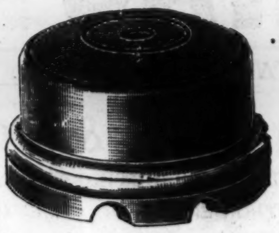

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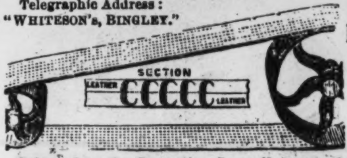

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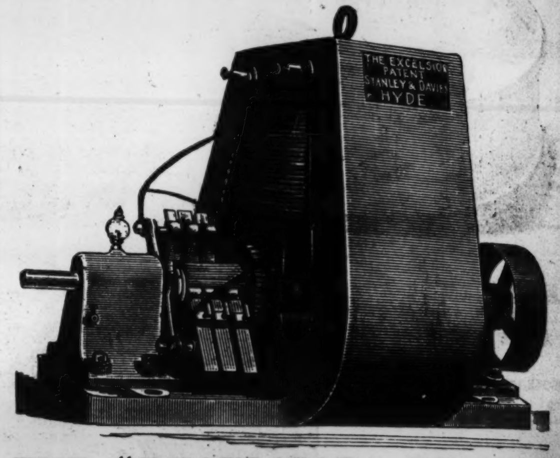

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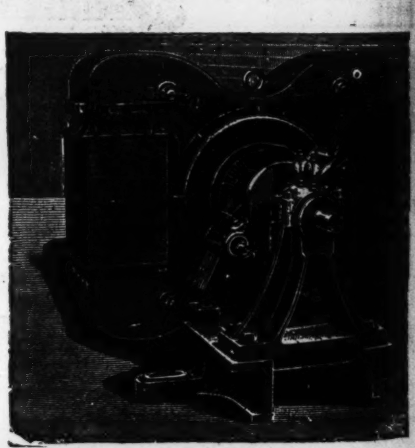

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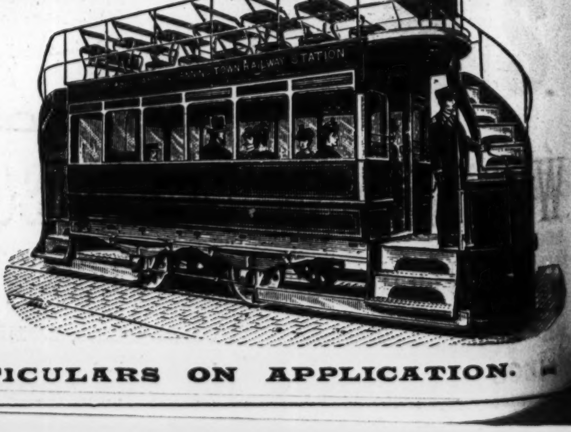

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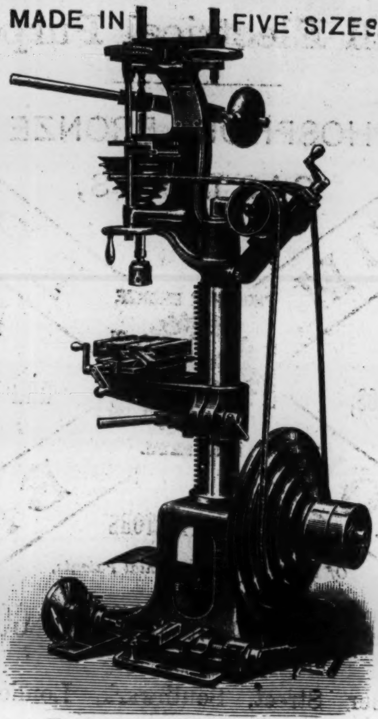

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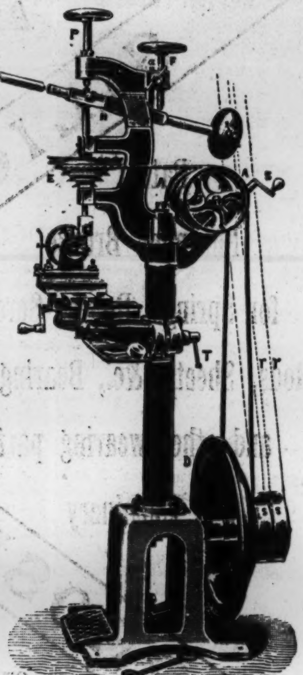

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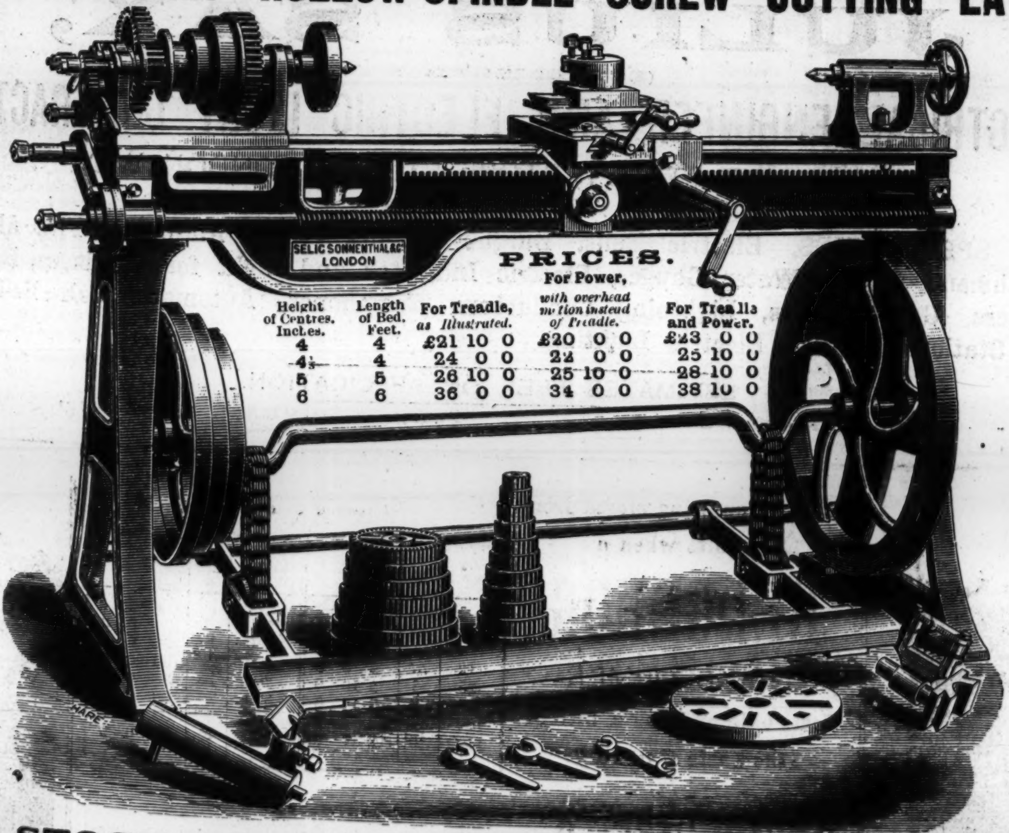

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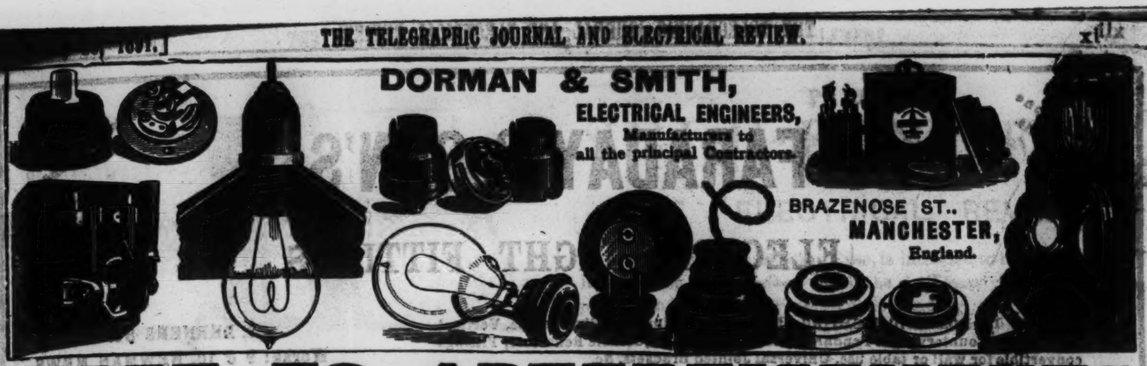

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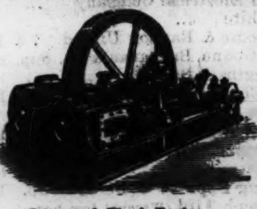

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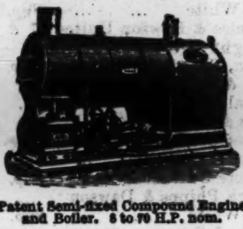

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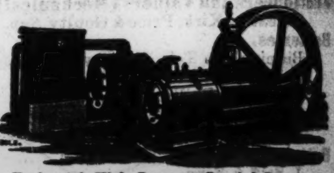

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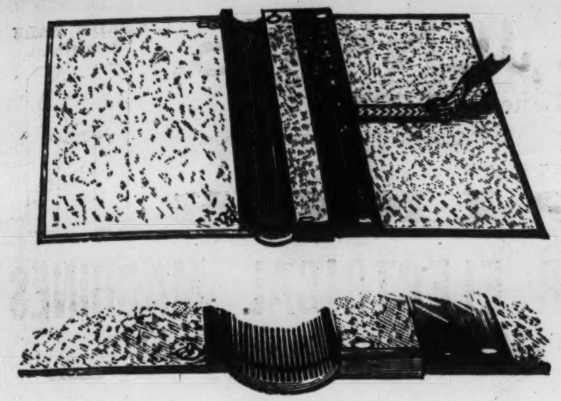

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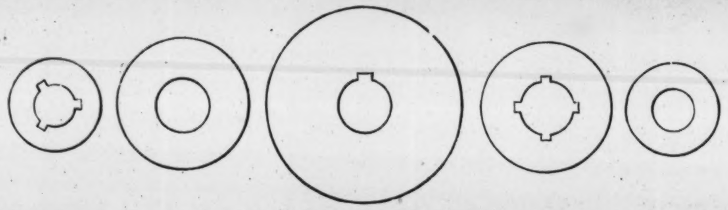

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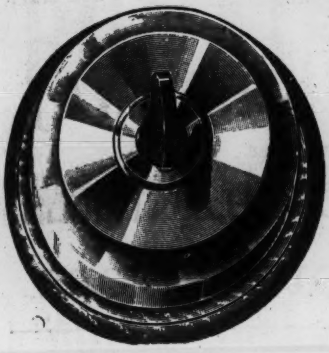

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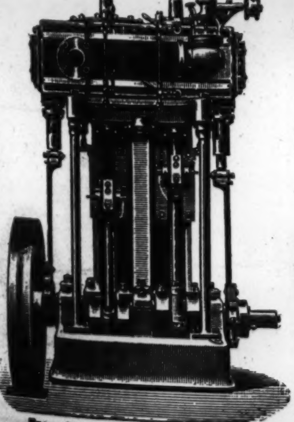

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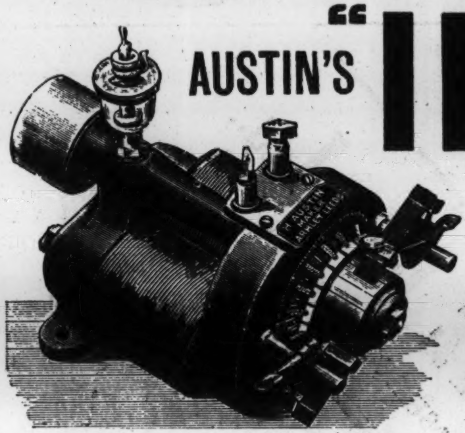

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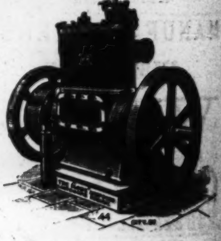

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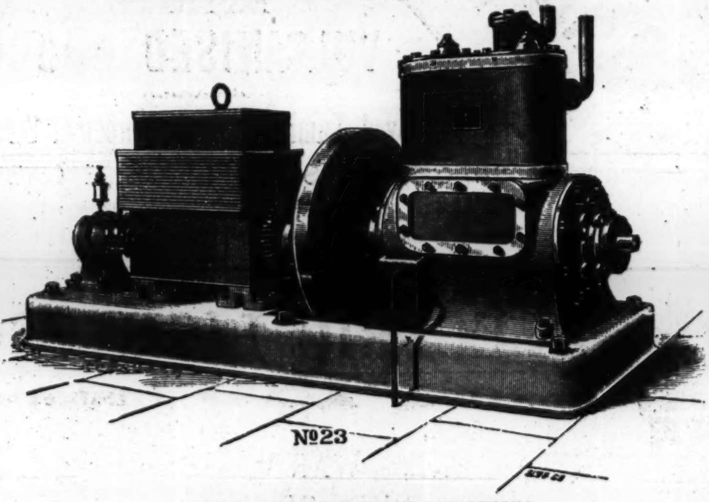

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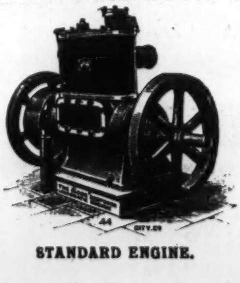

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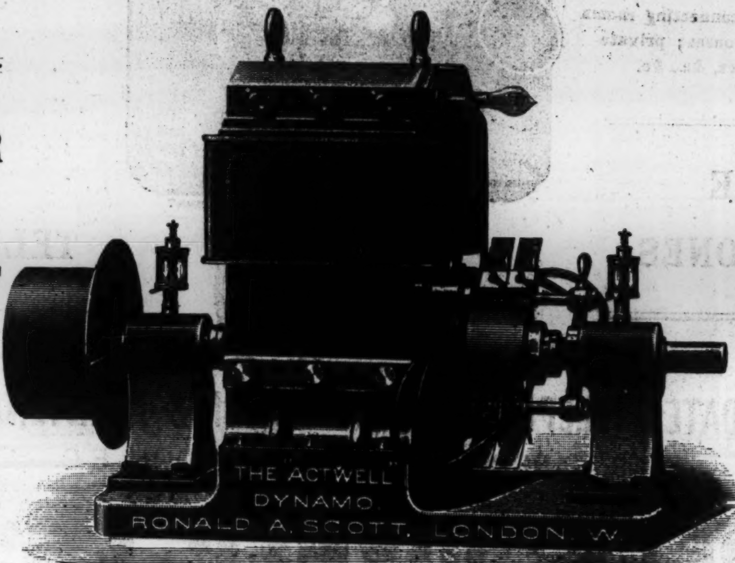
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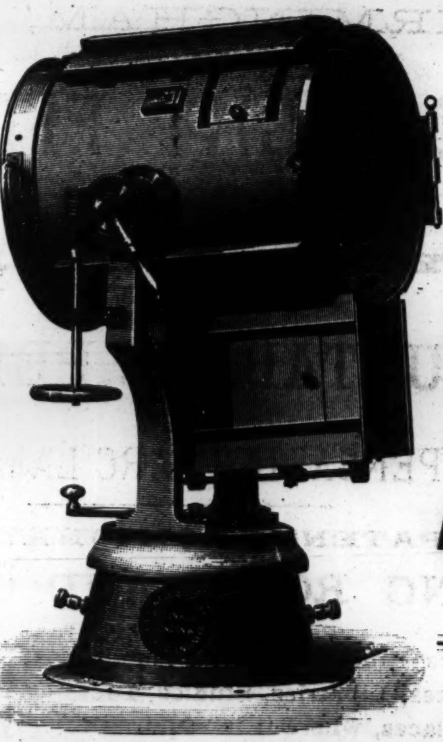

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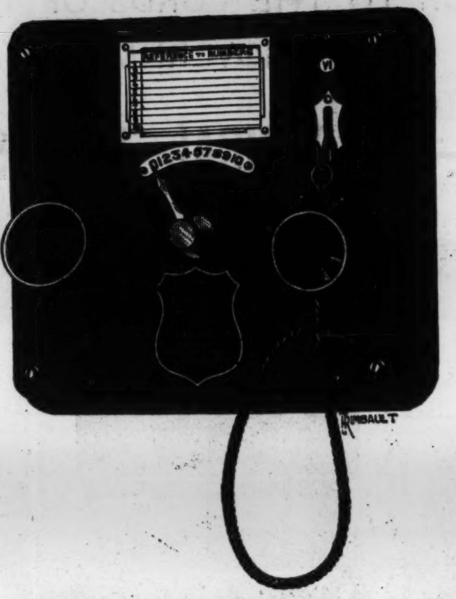

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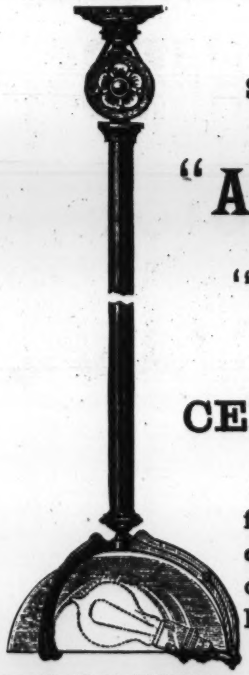

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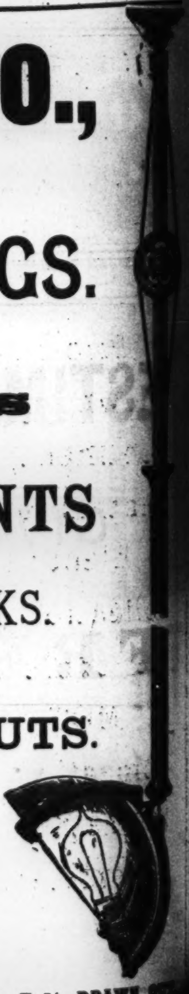

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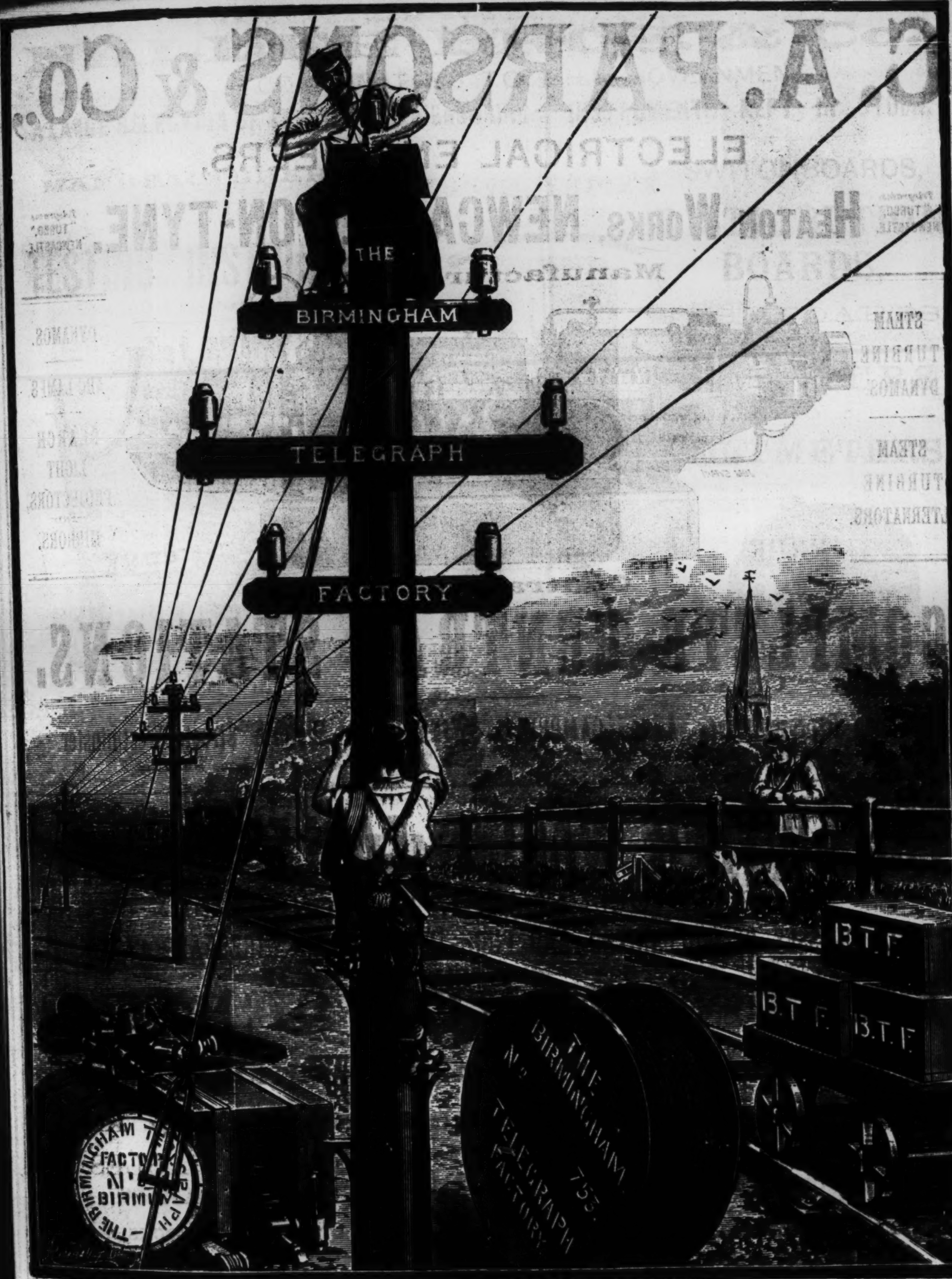
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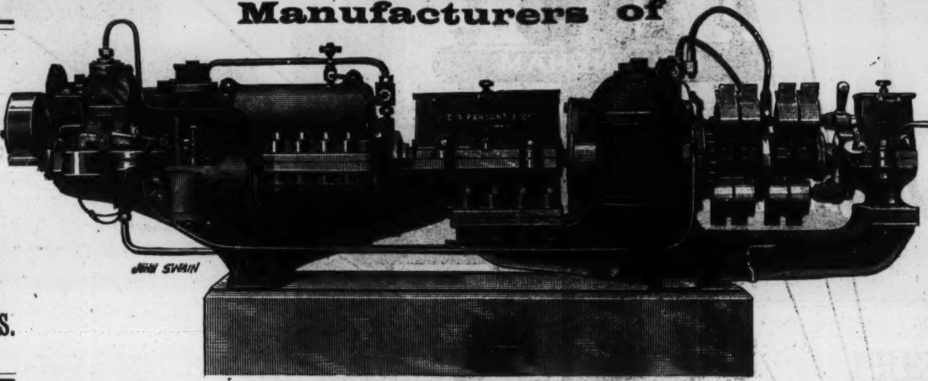

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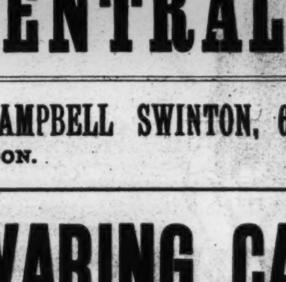

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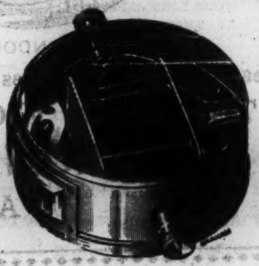

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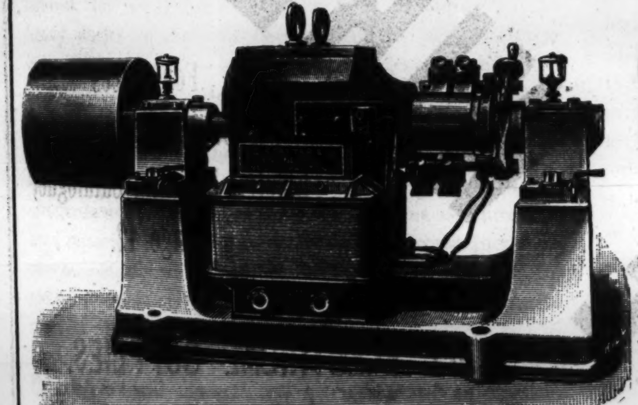

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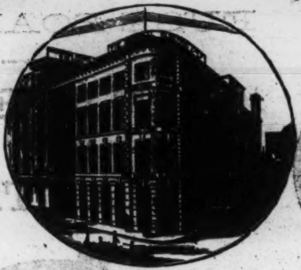

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THE ELECTRICAL INDUSTRY IN FRANCE.

OUR Parisian contemporary the *Bulletin Internationale de l'Electricité*, recently published, in articles extending through seven numbers, a report on the projected French tariff in relation to the electrical trades of that country. The report is addressed to the Association of Electrical Industries by M. Sciama, manager of the "Ancienne Maison Breguet." The conclusion reached by M. Sciama is, that in nearly all the departments of electrical manufacturing the Frenchman is no longer able to hold the home market against the foreigner. Ergo, he must be protected by heavy duties or he will be crowded out and foreigners will monopolise the supply of electrical manufactures in France. We fear that M. Sciama's *confreres* will hardly thank him for this frank avowal that their rivals in other countries are getting ahead of them. If French manufacturers cannot hold their own market, the bearing of the circumstance on the export trade is so obvious as scarcely to need remark. It is a notification to all the world that Paris cannot compete with London, Berlin, and Vienna, for the electrical orders of South America, Australia, and the other markets whose supplies are drawn from Europe. To be sure France does not now occupy one of the foremost places in foreign electrical markets. The creation of an artificial dearness has already been so highly developed that French manufacturers have fallen behind English and even German ones in the race for the "Colonial" trade. But in spite of all the disadvantages to which they are subjected by legislative interference with the natural course of trade, the ingenuity and taste of French inventors and the industry of French artisans have hitherto obtained a certain proportion of the electrical trade of the world. The tendency of the legislation now sought for must be of course to sacrifice the export business for the sake of monopolising the home trade. The arguments used by M. Sciama to prove that the French manufacturer requires legislative aid in his struggles are of the usual protectionist order. He marshals his statements, however, so baldly as to render the absurdity of the argument only the more evident. His main reliance is in figures purporting to give the prices of labour and materials in France as compared with Germany, Belgium and Switzerland. The great electrical manufacturing nations of the world—Great Britain and the United States—are omitted. It would be uncharitable to suppose that they were left out because their inclusion would not have served the desired purpose. His statement is that both materials and labour are dearer in France than in the other countries mentioned. Assuming that the only elements entering into the cost of an electrical instrument are the value of the materials and the price of labour by the day, the conclusion is that French manufacturers will be extinguished unless the legislature comes to the rescue. It seems very singular that M. Sciama should helplessly assume the higher prices in France to be in the nature of things, instead of enquiring into their origin, and that he should propose to make the manufactured article still dearer by still more artificial means, instead of endeavouring to place his country on an equality with its neighbours by utilising all the means in its power to bring prices down. Taking one consideration with another it seems to us that English manufacturers may look on with equanimity while our neighbours are putting on tariffs which serve to keep them out of prosperous markets.

ELECTRICITY FOR NOTHING.

SOME months ago, at a meeting of the City Commissioners of Sewers, one of the members of that body moved that the report of the Electric Lighting Committee be "referred back" to the Committee, on the ground that he had been told that a new process of generating electricity without the aid of steam engines and dynamos, and at an exceedingly small cost, would shortly be introduced into London. Our readers will remember that the Perreur-Lloyd system, which we had previously shown to be based on erroneous ideas, was the process which had dazzled for the moment the City Commissioner. The principal feature in M. Perreur-Lloyd's system of generators was the erection of works for the manufacture of chemical products—sulphates, simple or double chlorides of copper, iron, zinc, manganese, nickel, &c.—in which electricity was considered only as a sub-product.

It will be unnecessary to enter into details as to the merits of the Perreur-Lloyd system, but its demerits are shown further on, and we believe the process has not been worked on a practical scale either in France or in England. It has, however, been the means of effecting another scandal in the annals of electrical company promotion, as was shown in the two actions decided in the Sheriff's Court on Thursday last week. In the first case, Mr. Joseph Mitchell, a Yorkshire colliery proprietor, was the plaintiff, and M. de Vesey, the defendant, was a Frenchman, and the promoter of the Perreur-Lloyd system for generating electricity by chemicals. The plaintiff stated that in July, 1889, the defendant called upon him, and showed him two pamphlets, which went to prove that this patent could produce electricity free of cost, and was about to be applied to the streets of London, under the direction of Sir Henry Roscoe. The defendant persuaded him to advance £2,800, to float the scheme.

Mr. Scudder, principal assistant to Sir Henry Roscoe, gave evidence to the effect that the system was tried in London, and found to be an utter absurdity. This called forth the remark from the Under Sheriff that the process was "Something like sending out perpetual motion," with which Mr. Scudder entirely agreed. The Under Sheriff remarked that it was a wonder that anyone could advance money under such circumstances, and it was a pity that the jury had not the power to inflict punishment. Eventually the jury awarded plaintiff the sum of £2,800 damages.

In the second case Mr. Wm. Cox, of Fairfield Hall, Harrogate, Yorkshire, sought to recover the sum of £2,200 which he had advanced to M. de Vesey under circumstances similar to those detailed in the previous case. The jury assessed the damages in this case at £2,200.

It is rather astonishing that the defendant was able to induce the two plaintiffs to advance a total of £5,000 in order to float the system, in view of its not having been worked on a practical scale. The plaintiffs must, however, be congratulated for having proved that the money they handed over to the defendant had been obtained by false pretences, and for having had the return of their money awarded to them. Whether they will get it is another matter. Possibly a portion of the £5,000 was expended in fitting up the Perreur-Lloyd system in a large shed over a year ago in Eagle Street, off Red Lion Street, W.C., and in the expenses incidental to that establishment, M. Perreur-Lloyd's journeys from Paris to London, and *vice versâ*, &c. It was, however, a notorious fact that M. Perreur-Lloyd, or his deputy on the premises, was not disposed to let any one learn too much about the system; but taking the subject generally, it is satisfactory to find that the process did not result in the formation of a company which might have fleeced investors of many thousands of pounds.

We only regret that a report made by Sir Samuel Canning and others on the Perreur-Lloyd system did not make its way into court. The demolition of the electrical part of the scheme would have been even more complete than the chemical, which was undertaken by Sir Henry Roscoe.

THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED.

AGAIN the *Oracle* has spoken—the daily one—under date 17th inst. It is not happy in its mind concerning the prospectus of the above company offering to the public £100,000 in debentures in exchange for a like sum in hard cash, and after criticising the prospectus by the aid of the balance sheet and profit and loss account as side lights, and gentle references to Somerset House registers, it concludes that it is "not disposed to look upon an investment in those debentures as an attractive one," in view of the fact that the £10 shares of the company, notwithstanding the recently paid six per cent. dividend, only stand at about £7 each, "and are not very strong at that," making the dividend on the shares, if purchased at the market price nearly 9 per cent. even if future dividends should only be at the same rate as that paid on the first year's working. As the second year's working has not yet happened there should certainly be to the speculative soul more pleasure in buying the shares than the debentures, because of the element of chance introduced into the transaction. But to the more slow-minded and cautious investor the knowledge that the whole company was pawned, stock, lock and barrel, for the security of his interest would doubtless be more pleasing, for should the manufacture of dynamos, transformers, accumulators, &c., not leave a profit, and that of sub-companies cease, it might be that the contented six per cent. man would receive his own with usury, while nothing was left for the shareholder but gnashing of teeth. It is wonderful how large figures of property and assets become small under the auctioneer's hammer.

Besides expressing its opinions the *Oracle* propounds a riddle. It enquires pathetically concerning the difference in the amount paid to the companies and for patent rights purchased by the electric Construction Corporation and that disbursed to Mr. Tarver the nominal vendor. The nominal vendor is, as Mr. Marks explained in court, an ordinary commercial factor. With such high authority as to his necessity and usefulness we need not discuss the question, especially at this late hour, as to whether Mr. Tarver was singular or plural, whether he had £100,000 for the labour and responsibility of promotion, or £100 for the use of his name. It is not probable that the public will ever be gratified by a full knowledge of the details, or the names of the beneficiares. Nor is it necessary. It may well be sufficient for them to know that a good round sum has been withdrawn for ever from the dividend-earning power of the company and will proportionally lessen any dividends which may be paid to the shareholders.

CANDLE-POWER.

THOSE who have had to use the electric light, whether produced by the arc or by incandescence, can have hardly failed to feel that although the photometric power of the particular lamps in use may have been equal to that produced by a similar number of candles, by oil lamps, or by gas burners, yet there was a sense of something wanting which it was difficult to define. The fact of the candles, lamps or gas burners having large surface of flame seem to give a sense of there being more light, which, were it not for the fact of the comparative absence of heat and atmosphere vitiating tendency, &c., of the electric lamps, would probably have very great weight in deciding the comparative advantages of the methods of illumination. At the Institution of Civil Engineers, Sir David Salomans recently said that "whatever might be said to the contrary, it was impossible to see at night time with equal effect, unless obscured 16 candle-power glow lamps replace a 5-cubic-foot gas burner." Sir David has also pointed out that although an 8-candle-power glow lamp in a clear globe may have been shown to produce as much light as the average 5-cubic-foot burner, yet it did not follow that an 8-candle-power glow lamp could be used with equal effect to replace a 5-cubic-foot gas burner, for the nature of the light was very different. The electric lamp gave a light of greater intensity, but much less diffusion, and it was better to use a frosted or obscured globe, though 16 to 17 per cent. of the light was thereby lost, because the extra illuminating surface of the frosted globe, and the greater diffusion, more than compensated for the loss. Now the expression, "greater intensity but less diffusion," may indicate in a general way what is actually the case, but asked for a very exact definition and explanation of the meaning of the statement, and we imagine few would be able to give a satisfactory reply. Some clearing up of the whole matter is required, and we would invite correspondence on the subject, so that something precise may be formulated. Of course, we do not ask for a mere string of words which, though they "read well," and contain an elaborate scientific explanation, at the same time may not convey a clear and plain meaning.

IMPROVEMENTS IN COPPER SMELTING.

MR. GILCHRIST, who, in conjunction with the late Mr. Thomas, developed the basic process in its application to the production of iron, has recently devoted his attention to the smelting of copper, with a view to the elimination of its impurities by similar means. Mr. Gilchrist points out the difference in importance of the application to the two metals, and the results expected from the application of his improved process to copper are rather increased yields than greater purity. It seems likely that both these desirable results may be attained, according to the views expressed at a recent meeting of the London section of the Society of Chemical Industry. It is stated that some enterprising smelters, being satisfied with the prospects, have taken the matter up, and are making the necessary alterations in their furnaces to enable experiments to be conducted on a large scale. The electrical industries are so largely interested in the cheaper production of copper, that we hope to learn in due time of the success of the experiments, even though the improvements should be but slight.

Patent Fees and the Public.

Industries, in its leader of last week's publication, takes exception to the patent office scale of fees, and thinks it deplorable that a public department should be made a source of revenue. The writer insists that an inventor should be able to secure protection for his invention by payment of a very modest fee, which should be fixed at an amount just sufficient, on the average, to cover the expense incurred by the patent office for clerical labour, documents and cost of printing specifications; he admits that the expenses of government of a country must be met by the public submitting to taxation, and the necessary funds be raised with the least apparent pressure on the public, and that, as a rule, the best method is to institute taxes which appear to fall on the wealthy and not to affect the poorer classes. This statement savours somewhat of electioneering speeches before a constituency of working men. A patentee is protected by the present practice for some four years by the payment of not an exorbitant charge; it is only after the expiry of that time that the fees become heavy, but even then he would not have so much cause to grumble were his rights less liable to be challenged in the Law Courts. The officials of the patent office should not pass a specification unless, after genuine research, it comes unscathed through the ordeal. We think that patentees generally should make this point the salient one in any attack on existing law, and if, as many people consider, protection to property is a bargain between the State and the public, the latter should claim as a *sinè qua non*, in return for payment for this protection, a greater security than the present patent law furnishes. Before the days of patent laws inventors and manufacturers obtained protection by a system of close guilds whose processes were kept secret among their members. These guilds mutually defended the interests of each other. In the great instance of the Hausu League the merchants and manufacturers of the cities composing it, ruled the commerce and financial matters of Northern Europe for hundreds of years, and upheld their supremacy by force of arms when requisite.

Safety Fuses.

AT a recent banquet held in one of the assembly rooms of a new building at Newcastle-on-Tyne, the hilarity of the proceedings was somewhat abruptly interrupted by the sudden extinction of the electric light; the cause being stated to be the giving of a safety fuse in the building. This is by no means the first time such a mishap has occurred in connection with electric light installations, and it points to either carelessness or something wrong in the fuse system itself. Possibly for some time to come the use of fuses may be necessary, but eventually they will be looked upon as relics of barbarism, for if proper regulating devices were used at the source of power, the fuses would certainly not be required, and it seems conceivable that such devices may be as certain in their action as the governor of a steam engine.

Newspaper Science.

PERHAPS it is as well that newspapers are not all endowed with scientific members on their staff, otherwise the hard and dry facts of science might prevent many a lively and interesting, though inaccurate, leaderette from being written. The *Evening Standard* in its issue of the 14th refers to an accident which recently occurred in the United States by which a boy was killed through touching the guy wire attached to an electric light pole. "In the first place, it is clear" (says our contemporary) "that a wire acting as a guy to a pole would not be in contact with the electric wires, unless, indeed, one of these had broken, and was hanging against it. But even in that case the electricity would flow down the guy wire to earth, and as an iron wire is a vastly better conductor of electricity than the human body, the fluid would not go out of its way to pass through a boy or a man who happened to take hold of the wire." Wouldn't it? Do guy-wire stays necessarily always make good earth, or earth at all?

Consulting Engineers.

THE Electric Lighting Committee of the Hove Town Commissioners have been authorised to call in Mr. R. E. Crompton to act as their consulting engineer. How such an appointment could have been made it is difficult to imagine. Mr. R. E. Crompton, it is needless to say, stands amongst the highest as a trading electrician, and his ability no one would venture to question, but in an appointment of the kind a man's hands must be perfectly free and in no other branch of engineering should we hear of a trading engineer being identified with one who acts for consulting purposes; the two sections of the profession are, and should be, preserved rigidly distinct, otherwise jobbery is, sooner or later, the inevitable result.

Telegraphic Interruptions.

THE celebrated work on Iceland which contains the chapter giving a dissertation on "Snakes" in that country, states, as is well known, "There are no snakes in Iceland," this being the sole contents of a very interesting chapter! *Apropos* of this, our contemporary, the *Echo*, in its issue of the 14th, states that "one curious scientific effect of the sudden thaw yesterday deserves to be mentioned. There was an almost general paralysis of communication in overhead telegraphy in the Metropolis last night, and it probably, if the Department were to speak, extended to the country. The failure was the result of the sudden and extraordinary moisture. What occurred was this. The current would not run to metals. It went to earth. "Gone to earth" is the cant phrase of the operator when he cannot get his circuit. The current went away in drip. Water is a good conductor of electricity; dry air is a perfect non-conductor. Electricity will get away whenever possible." Excellent scientific explanation! But there is only one defect in the statement, viz., there are no overhead wires in the Metropolis belonging to the Department, they are all underground.

Tariffs on Electrical Appliances.

HITHERTO the custom officials of foreign countries have been considerably exercised as to the proper category in which to place electrical apparatus. Tariffs framed in a bygone age proved inefficient in defining the exact duty payable on a dynamo machine. It was a great tax on the official mind to recognise the subtle distinction between such an instrument and an infernal machine, often to the satisfaction of the exporter, but more frequently to his chagrin. Manufacturers did not object to have electrical appliances excised under miscellaneous articles, if it were found advantageous so to do, if on the other hand machinery were admitted at a lower rate it was but natural to strive for a lower duty. There appears to be now an attempt to introduce fresh clauses into tariff bills, and recent decisions will affect the importation more or less. The Netherlands customs authorities have decided that electric accumulators follow the *régime* of philosophical instruments, and pay a duty of five per cent. *ad valorem*. A peculiar state of things prevails in Nicaragua; while almost every manufactured article is permitted to pass the ports at low rates of duty, apparatus for telegraphs and telephones is entirely prohibited.

Elmore's Copper

WHILST our correspondent, "An Original Shareholder," who we believe to be behind the scenes, expresses sympathy with those who think the Elmore process should be viewed in actual work, it is curious that at this late hour he talks of new improvements and discoveries which are being constantly made and applied, which renders it injudicious to allow the works to be inspected at the present moment. Now it has all along been said by the advocates of this process that it was long ago perfected, that the copper was beyond compare in every way, aud that the cost of production was ridiculously low; how then is it that these new discoveries are continually cropping up? Perhaps all doubts will be set at rest on Tuesday next, the day appointed by the Elmore Patent Copper Depositing Company for the public inspection and exhibition of the system at the works, near Leeds. Whether we, like Rip Van Winkle, have been sleeping, remains to be seen. Unkind remarks were made about the REVIEW by interested people, when we took Perreur-Lloyd's system to task. Time alone will show whether our strictures on Elmore's have been as well deserved.

Dismay in the Central Institution.

WE would call attention to the letter (reproduced on another page) which Professor W. E. Ayrton communicated to the *Times*, of Wednesday. It is not necessary to refer to the opinions which have recently been expressed on the subject by other gentlemen, it is sufficient that Prof. Ayrton has given facts which go to show that the proposed new railway should be kept within reasonable distance of the Central Institution. Anybody who has ever worked in the submarine cable manufactories alongside the Thames knows perfectly well the effect produced by passing ships at considerable distances away, upon the delicate instruments employed in testing; therefore the frequent passage of heavy carriages a few yards off the Central Institution would be calculated to upset any scientific research of the kind indicated by the Professor.

Telephone Rates.

OUR esteemed contemporary, the *Electrical World*, discussing telephone rates, draws a comparison between Berlin under imperial government control, with New York under a private organisation, and in so doing overlooks, as one is so apt to do, the fact that it is not safe to make comparisons without making them thorough. To arrive at a just conclusion the comparison must be carried much further. In the "States," as elsewhere, under private enterprise, differential rates prevail according to the size of the exchange and the number of subscribers to whom facilities of communication are given. Berlin is fortunate enough to have the same advantage in regard to telephone rates in comparison to other large cities as the penny postage gives to the correspondent who sends a letter from Land's End to John O' Groats over his fellow who pays the same sum for the transmission of the same letter to the next street. The advantage in the first case is obtained at the expense of the second. The same rates for exchanges of varied size may be advantageous, but it does not do to select the largest in making comparisons with other countries where the same conditions do not exist.

Electricity Meters.

IF we take up almost any electrical journal we find it stated that a good electricity meter is still a desideratum. It is astonishing how many weak points develop in these instruments, and although complication is undeniably a bad thing, we very much doubt whether what is called for, viz., a meter possessing the threefold attributes of cheapness, simplicity and reliability seems likely to be designed. If people imagine that electricity meters can ever be made as easily as, or even on the same lines as, gas meters, we think they will find themselves mistaken, nor do we think the object in view should be to design an instrument, which if unprotected, would stand rough handling, but rather to devise a satisfactory method of efficiently protecting what must necessarily be a delicate piece of mechanism.

STORMS AND TELEGRAMS.

By W. Slingo and A. Brooker.

The winter season is at all times an interesting, and frequently a busy period, for telegraph engineers, for it is then that sudden frosts and heavy snowfalls wreak such havoc upon the various lines of telegraph as to jeopardise more or less that intercommunication which is essential to modern commerce and enterprise. It is the general impression that a long-continued frost means little short of disaster to the telegraph system, but this is one of the greatest fallacies ever conceived by those not directly interested in the matter. There appear to be, indeed, very few outside the telegraphic world who are able to appreciate the actual circumstances which tend to make the telegraph engineer's life other than a happy one. As a matter of fact, the present winter, with its long and almost incessant frost, has given less trouble, and caused fewer interruptions, than have been experienced for some years past. The first night's frost in early winter is usually the one which does most damage, for the wires are then tightened up for the first time, and such weak places as may exist give way. These faults having been remedied, matters may then proceed very smoothly until a thaw sets in, for not only does a clear frosty atmosphere maintain good insulation, but, owing to the excessive cold, outdoor work is rendered uncongenial, and "working parties" appear to confine their energies to other spheres. It is, indeed, no infrequent experience for a fine day in the early summer to be accompanied by a greater number of interruptions than when the weather is less propitious for alterations and renewals.

Really the greatest inconvenience is felt not with the coming on or during the continuance of the frost, but, more especially if snow has fallen, during the period of thaw, for then the poles and insulators are in their worst possible condition as regards insulation. Dust, smoke, and other conducting particles have been deposited upon the snow, and as it melts a ready path is afforded for the escape of the current. Even then the insulators are not left clean, and the earnest prayer of a telegraph engineer at such periods of the year is that the thaw may be rapid, and be accompanied or immediately followed by a heavy cleansing rain.

During the thaw the loss of current must be met as far as possible by considerable increases in battery power. This can be done with safety to a very much greater extent than might be supposed, if the poles are efficiently earth-wired so as to prevent contact between wire and wire across the arms. It is indeed a most interesting fact that on such a day as we are now supposing (last Tuesday week, for example), the joint resistance of the insulators is far less than that offered by the path which it is desired that the current should take, viz., through the apparatus to earth at the distant end of the line; and yet such lines can be made to work by augmenting the battery power and taking full advantage of the delicate adjustment to which the beautiful apparatus of to-day is susceptible.

A little reflection will make it evident that in such cases a low conductor-resistance is of great advantage, because a considerably greater proportion of the current then finds its way to the distant station, a fact which points very strongly to the desirability of employing copper instead of iron wires.

The general public, or, for the matter of that, the general electrician has little knowledge of the difficulties referred to, because they are, as a rule, so speedily surmounted as to avoid any appreciable interruption to traffic. It is only on such occasions as phenomenal storms of snow, hail, wind or rain that outsiders are made aware of the difficulties which result from causes that no amount of engineering skill could entirely provide against, although, as will be shown, much may be done to minimise disastrous consequences.

It is probable that the severest ordeal for an overhead system is one similar to that which was experienced on the night of December 26th, 1886. The result was, that at one time, out of the many hundreds of wires radiating from London, only five wires were workable, and these were all on one line, with one of the poles broken off close to the ground, and supported by the wires. Such an effect deserves the closest study to ascertain the actual cause.

In the early evening the snow began to fall thickly, in a still and comparatively mild atmosphere. It was so near the melting point that it adhered to everything with which it came in contact, and as there was no wind to blow it from the wires and poles it accumulated rapidly, and, subsequently freezing, formed solid tubes of ice and frozen snow around the wires, in many cases 3 inches in diameter. The aggregate surface exposed to the wind was thus enormously increased, and that, too, at a point remote from the ground, so that when, as was soon the case, the wind did spring up, the breaking stress at the ground line of the poles was simply tremendous, and it is little to be wondered at that a general collapse ensued, more especially on those lines which ran at right angles to the direction of the wind. It is manifestly impossible to erect a system guaranteed to effectually withstand such an attack, but it is, nevertheless, certain that were such a storm to be repeated to-morrow, the results would be far less disastrous than was the case in 1886. On that occasion the storm found innumerable weak places, all of which were ruthlessly swept away. The great sin in telegraph construction had been the overburdening of poles. Poles originally erected to carry a few wires were made, as the increased traffic demanded, to carry double, and even treble, the number, and these poles had most of them been in use for many years, and were in a more or less unsound condition. The question of staying had, moreover, been sadly neglected; many heavily-burdened poles were entirely without stays, and, generally, the stays were too weak for the purpose. It required much less than a miracle, therefore, to sweep away mile upon mile of such lines; poles were snapped off at the ground, others were wrenched bodily from their settings; others, again, were thrown over hedges and across roads, the more gymnastically-disposed turning complete somersaults before they reached a suitable resting place. Not only were the wires hopelessly entangled, but in some cases where the poles had been hurled into a ditch, they were embedded in several inches of ice.

Experience teaches. Wholesale renewal was, of course, the order of the day, and, fortunately, although it had to be hurriedly effected, it was on a system more in accordance with the actual requirements, and approximating more nearly to the real necessities of the case. Poles of greater dimensions were employed, and more frequently and efficiently stayed New wire was used everywhere in place of the old wire half rusted through, and replete with antiquated and rusty joints. Boucherised poles are rapidly dropping out of use, and it is interesting to observe that when one of these coppered poles was fractured the break was generally clean, like that of a carrot, while a creosoted pole splintered in the usual way.

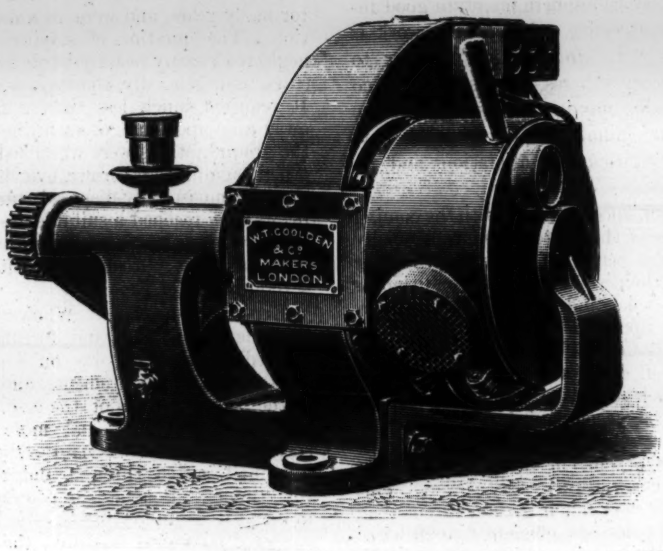
It will be obvious that many weeks, and in some cases months, elapsed before the wires were joined through, and then the work was frequently of a temporary character. For a year or 18 months afterwards men were busy in various parts of the country cutting out the temporary dry joints and substituting permanent soldered ones of the orthodox type, properly binding the wires to the insulators, straightening poles and adding struts and stays. The greatest trouble and inconvenience was caused by the necessity for renewing the poles, which had to be transported long distances, and then to be properly set in position.

Most of this would have been avoided had the lines been constructed on the basis that the strength of the pole should be greater than the added strength of the wires supported by it, which means simply that the wires should all give way before any damage is done to the pole. In such a case the work of renewal would be comparatively easy even in bad weather, for it must be remembered that hole digging in frosty weather and the carriage of heavy poles through deep snow, and often along roads remote from railways, are tasks of no light nature. Possibly this is another argument favouring the use of copper wires, which, for equal conductivities, are less than one-fifth the weight of iron; they are also mechanically weaker and more easily run.

(To be continued.)

THE "GOOLDEN" MINING MOTOR.

THE firm of W. T. Goolden & Co. has been engaged in the development of the application of electric power to mining work for a period extending over the last five years, and were the earliest to recognise the difficulties likely to occur in connection with mining work. One of the principal of these is the very rough conditions and dirty situations in which the motors have to be used, and a further difficulty in coal mines is the danger that occasionally arises from the presence of explosive gases. For ordinary purposes, even in coal mines, it may be safely assumed that the motor will not be working normally in an explosive atmosphere, and it is therefore sufficient to carry out the arrangement patented some years ago by Messrs. Goolden & Co. of enclosing the whole armature and brushes in air-tight and dirt-tight coverings. These coverings would be sufficient to exclude an explosive mixture for many hours, and before such mixture found its way into the neighbourhood of the armature or brushes, the condition of the atmosphere would have been noted by the attendant, and the current cut off. The annexed cut shows one form of "Goolden" mining motor, which embodies, besides the complete enclosing of the armature, various other important features. The construction of the armature is unusually strong, and the wires being keyed in every position, and insulated from the core and from one another by means of mica, a construction is arrived at which has enabled these machines to be used for driving hauling machinery, subject to great vibration and shocks by the use of gearing, thus doing away with belts, chains and other forms of connection, all of which have been proved in practice to be unsuitable for working; at all events, in parts that are in any way portable, which should be the case with the bulk of mining work.



The enclosure of the armature has been supposed by some to be impossible, on the ground of the want of ventilation, and in the discussion on mining motors, which took place some two years ago at Sheffield, at the meeting of the Mining Institute, several eminent electrical engineers, including Mr. A. Snell, stated that, in their opinion, it was impossible to work a motor thus enclosed. It is sufficient to add that even on that date Messrs. Goolden were using motors working up to 30 or 40 H.P. with such enclosed armatures.

For cases where it is desired to make a machine absolutely safe in an explosure mixture, Messrs. Goolden's patents also cover an arrangement in which the volume of gas enclosed in the cover of the brushes in contact with the commutator is as small, or less, than that enclosed in an ordinary safety lamp, and, therefore, should ignition result, the volume of gas compared with the length and cooling surface of the outlet is such, that no flame will appear externally. These motors are now being widely adapted for use in electric coal cutting machinery, electric pumps, electric haulage and rock drilling plants, and on a future occasion we hope to illustrate and describe some of these applications to practical work.

THE ELECTRICAL WORKS OF THE INTERNATIONAL ELECTRIC COMPANY AT VIENNA.

[FROM A CORRESPONDENT.]

As I reported in November last, the Vienna works of the above company were opened on November 14th. It may be of interest for your readers to learn fuller details of this successful and really magnificent installation.

After a rapid journey through the inner city, the Prater Strasse and the Prater itself, along the coal depôts of the Northern Railway, we arrive at the so-called Danube Town, where the electrical works in question have been erected close to the Danube, outside the most densely inhabited parts of the city, that is, in a district where establishments employing steam power are most fittingly placed.

We stop in front of a building erected in a tasteful rustic style. From the spacious court, provided with rails for the conveyance of coals, we enter the boiler house, in which three powerful steam pumps first claim our notice. These pumps serve for feeding the boilers and for supplying condensing water. In the boiler house itself there are placed six tubular boilers, each of 300 horse-power, with their accessory apparatus.

In the immediate neighbourhood of the boiler house is the engine room. Here there are at present erected a 300 H.P. steam engine, with an alternating current dynamo, two engines of 600 H.P. each, with their accompanying dynamos, and three steam engines of 50 H.P. each, with their exciting dynamos. Each steam engine is directly connected with an accompanying dynamo. The foundations for a third 600 H.P. steam engine, with an alternating current dynamo, have been already completed, and the erection of the machinery has been begun. The electrical works will therefore operate with the total capacity of about 20,000 glow lamps, but arrangements are made for a successive extension to twice this capacity.

The current generated in the dynamos will be led underground to the switchboard, which takes up an entire end wall and the half of one of the side walls of the building. On this board there runs for its whole length a massive copper rail of such dimensions that it can take up the current produced in the entire works, *i.e.*, about 40,000 glow lamps. With this copper rail there are connected by means of branch leads the numerous apparatus for measuring, checking, and regulating the current. It will be possible, too, by this means to check accurately the current generated in the machinery house and supplied to consumers by simply reading off the various apparatus.

From the switchboard the leads pass off into the city. They are all underground concentric lead cables, clad with iron. One cable leads through Crown Prince Rudolph Street, a second through the Prater. These two leads unite at the Prater Strasse, and branch off again into two cables.

One of them passes through the Prater Street, Aspern Street, Aspern Bridge, and round the entire Ring Street. The second passes through the Tabor Street. From the Ring the leads branch off radially, on the one hand, through the main streets of the inner city, and, on the other hand, to the different districts.

At present 8,000 lamps have been already connected to the net. Among the principal buildings thus illuminated are the Imperial Court, the palaces of Prince Salm, of Baron Rothschild, Baron Springer, the Vienna Club, the Mercantile Association, the Carl Theatre, the Agricultural Exchange, the terminus of the Northern Railway, and numerous banks, hotels, and private mansions.

THE PROGRESS OF ELECTRICAL SCIENCE IN 1890.

La Lumière Electrique, in a review of the advance made in the theory and practice of electrical science in 1890, remarks that although no great discovery, such as would mark an epoch in the history of science, was made during the past year, yet the various applications of electricity to industrial purposes have shown considerable progress.

The experiments of M. Hertz on electrical undulations have been resumed and repeated, but those investigations have not met with the results which might have been hoped for, nor has there much progress been made towards a solution of the electro-magnetic theory of light, although most scientists admit the theory as being correct.

The researches of M. Zenger indicate the important part played by electricity in the working of the celestial system, and it appears not impossible that this work may result in an entirely new theory in which electro-dynamic force is the active agent.

Leaving, however, the domain of theory, and considering electricity as a particular form of energy, more satisfactory progress has been made. With regard to the exact determination of the units of electrical measurements, nothing very striking has been achieved, but a large amount of useful work has been done in this direction, and carried on with perseverance, it has resulted in real advantage.

The large share of attention latterly given to the employment of alternating currents has been naturally accompanied by corresponding scientific investigation, and the study of transformers has been pursued until there remain but few details upon which there can be any hesitation; the question, also, of the employment of motors with alternating currents has received its share of attention, and the results have been productive of some very interesting observations.

A subject of some importance—the charging of accumulators by means of alternating currents—has, notwithstanding a great deal of close investigation and numerous experiments, been advanced but little towards solution.

The Deptford installation is duly praised, and the curious fact mentioned that with alternating currents on concentric cables having an appreciable capacity, the potential is higher at the distant end than at the starting point.

As a theoretical determination, Sir W. Thomson has shown, chiefly as regards coils spirally-wound, that the increasing of the thickness of a conductor does not always diminish the total resistance opposed to alternating currents; this total resistance comprising the resistance of the metal and that due to induction.

The rivalry between the advocates of alternating and continuous currents is briefly mentioned, and the merits of the two systems are thus described:—

Alternating currents permit of high-tension currents being transformed to low-tension without the assistance of any delicate apparatus, a valuable attribute as regards electric lighting.

Continuous currents afford easy storage, practicable motors, and little danger to life.

Mention is made of the progress reached in the construction of accumulators, but, it is observed, the attempts to replace lead by some other metal have not been very successful.

The experiments in electrolysis, and the study of electrolytes, are touched upon. With regard to the former, it is remarked that Mr. Gore, by measuring the electromotive force of two metals placed in different electrolytes, arrived at a method somewhat resembling spectroscopy as employed in chemical analysis.

The industrial applications of electrolysis, such as electric bleaching, electric tanning, &c., and the obtaining by the same means of certain chemical products, are briefly mentioned.

Some observations are made upon the great increase in telephonic communications, and the never ceasing flow of invention in the various appliances made use of: the phonograph is described as having received but little attention in France, whatever may have been its success, or otherwise, elsewhere.

In telegraphy, attention has been chiefly given to the increase of the working capacity of the lines, and with this view many new instruments for rapid transmission have been tried.

With regard to general progress in the industrial applications of electricity, America is indicated as being a long way in the van; more particularly with regard to electric lighting and the use of electrical tramways. As to the latter, it is pointed out that whereas in the United States there is scarcely a town which does not possess its electrical railway or tramway, it may be said that in Europe this method of propulsion is practically non-existent.

THE OULTON-EDMONDSON ELECTRICITY METER.

THIS Watt-Meter, for either continuous or alternating currents, consists of a set of clockwork having two "torsion balances" which keep identical time, except when current is being consumed. When a current passes through the main conductor it quickens the speed of one of the balances, and the difference of speed (registered on the dials in B.T. units) is a measure of the current consumed. A difference of 10 beats per hour = 1 B. T. Unit, and the measurement is proportional to the current throughout the whole range for which each instrument is constructed.

The clockwork is of first-class quality, with "high numbered" pinions. Both balances are driven by one main spring, the force of which is equally divided between them by a novel "differential gear," and their synchronism is consequently all but perfect.

The electrical arrangements consist of two "compound wound" solenoids, astatically attached to one of the balances, and swinging, the one *above* and the other *within*, the coils of the main conductor, and influenced by the current to be measured.

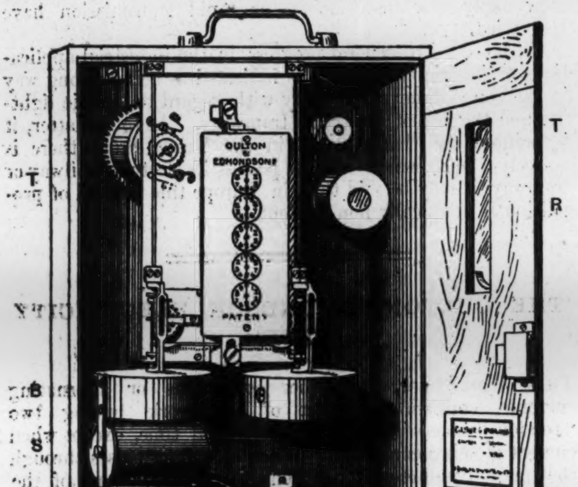
The principal winding of the swinging solenoids consists of fine wire, connected with a fixed resistance coil (by which the instrument is calibrated), and coupled across the supply terminals. In a 100 ampèremeter these high resistance or volt coils, consume about ·007 ampère on a circuit of 100 volts. By themselves, however, they would not give proportional readings. For in pendulums and chronometric balances, the force required to produce the vibrations is proportional to the square of the number of vibrations in a given time. If, therefore, a = the normal number of vibrations, and b = the number to be added by the current, the force required to produce a will be a^2, and to produce $a + b$ will be $a^2 + 2ab + b^2$; the difference $(2ab + b^2)$ being the force to be exerted by the current under measurement. With the volt coils alone, the force actually exerted would be in the ratio $2ab + b$ only. Upon each volt coil, therefore, there is wound a "correcting coil," carrying a very small proportion of the current passing into consumption. If correctly calibrated, this small current brings the ratio up to $2ab + b^2$. This correction is mathematically perfect, and makes the readings absolutely proportional throughout any range.

In meters in which the influence of the current on a vibrating pendulum or chronometric balance is the basis of measurement, the element of friction is entirely dealt with by the force of the clock, which supplies power exactly in proportion to the speed of vibration. The current under measurement has, therefore, no friction to overcome. Hence such meters register the smallest as accurately as larger currents.

The right hand balance weighs about 4 lbs. It contains two "timing screws" which are really small weights, and when screwed inwards will *quicken*, and when outwards will *slacken* the speed of the balance. The number of vibrations is about 15 per minute. The balance spring instead of being coiled as in a watch, is quite straight, and forms the means of suspending the balance, which thus vibrates practically without friction. This spring acts by "torsion," a principle familiar to all who have seen "the 400 day clock."

The left hand balance and its solenoids are of about the same weights as the above so as to vibrate in the same period of time.

Although driven by the same main spring, the two balances are free to move independently. The current for the volt and correcting coils is conveyed from the + terminal to a mercury cup placed concentrically with the left hand balance, into which a wire upon and concentric with the balance projects. After traversing the volt coils it is conveyed up the "torsion spring," and through the fixed resistance coil to a terminal near the top of the case and thence to the — main. The current traversing the "correcting" coils returns through the upper mercury cup to the — terminal of the instrument. This current is very small, as for 1 ampère on a 100 volt circuit it has to furnish a magnetic force equal to only $\frac{1}{1800}$th of that furnished by the volt coils. As, however, the turns in the correcting coils are much fewer than those in the volt coils, the actual current in the former may be (for 1 ampère) somewhat greater than in the latter, and it increases in proportion to the current consumed.



On the left hand side of the block the torsion spring carrying balance is seen opposite T; the two balances (on one of which is seen the timing screw) opposite B; swinging solenoids, S; main conductors in the form of straps at M, and *m*, *m*, —, and +, mercury cups. On the right of figure, opposite T, is the terminal for high resistance circuit; R, fixed resistance coil, and — + main terminals.

The denominator of the fraction $\frac{1}{1800}$, is the $2\,a\,b$ of the difference $2\,a\,b + b^2$ mentioned above when the balances normally vibrate 900 per hour.

The following is a summary of the advantages claimed for the Oulton-Edmondson meters :—

1. Their synchronism is much more accurate than has been attained in previous meters acting on the same principle.

2. They will go for three months without re-winding, even when worked up to their full capacity.

3. They will measure any current however small.

4. They give proportional readings over a longer range than any other mechanical meter extant.

5. The electrical energy consumed is less than in any other existing Watt-meter.

6. The dials register the consumption in plain Board of Trade units.

7. There are no "make and break" contacts.

MR. CROOKES'S PRESIDENTAL ADDRESS.

By S. ALFRED VARLEY.

ORIGINAL researches, such as those Mr. Crookes has published to the world through the medium of his address to the Society of Electrical Engineers, are full of interest to all scientific workers, and especially so to those who have never had the opportunity of traversing similar ground, for they enable physics to be looked at from a new standpoint, and consequently they help us to obtain a more comprehensive view of physical phenomena.

The subject dealt with by Mr. Crookes is so peculiarly his own, that criticism in any real sense of the term seems to be almost out of question, but it is of the very nature of original research—and this is what constitutes its value, that it suggests new thoughts tending in the direction of new departures—it may be by strengthening, or it may be by upsetting views previously held.

Although there has not been time to do more than to hurriedly glance through the address, it is thought that a certain method can be detected, and that general laws seem to prevail throughout Mr. Crookes's experiments, but what they seem at the first glance to teach, does not, in the writer's own case, help him to reconcile to his mind the now prevailing theory of the nature of gaseous matter; he, himself, has never been able to conceive that it is possible for gaseous molecules to possess within themselves the power to keep up a perpetual bombardment, propelling themselves continuously against one another as theory assumes, and that "when molecules come very near together" that "they should exhibit a repulsion varying inversely as the fifth power of the distance between them"—the Boltzman view, also, viz., that the molecules do not actually bounce against one another, but merely fly round in two interlocking hyperbolic paths," does not, in the writer's opinion, remove the difficulties which stand in the way of his acceptance of the theory.

It is a sound axiom that the laws of nature are absolute and never vary, and if this axiom be accepted, then it follows as a logical sequence that matter can never be anything else but matter, that energy must always be energy, and that matter can neither be transmuted into energy nor energy into matter.

A mass of matter is an aggregation of molecules, and molecules are an aggregation of atoms; and further, the molecules of a mass of matter are held together by the property which all matter possesses of attracting matter.

A block of ice presents facilities for studying the way energy and matter comport themselves in respect to one another. Energy, from some external source in the form of heat, can be imparted to ice, and the effect of combining energy with ice is not to raise its temperature, but to convert it into liquid water. The liquid condition results from energy overcoming the force of molecular attraction in such degree that the molecules become able to move freely over one another, and to be individually acted upon by gravity.

After the liquid state has been reached, the temperature of the water can, by imparting additional energy to it, be raised from 32° Fah. to 212° Fah., under the normal condition of our atmosphere, and after this temperature has been reached, additional energy separates the molecules apart from one another, producing the gaseous condition.

All masses of matter may be regarded as structures having associated with them more or less energy, the solid condition results from molecular attraction being the prevailing force, and the gaseous state is brought about when the percentage of energy relatively to the matter it is associated with is great enough to overcome the force of molecular attraction. Gases may be considered as being examples of a minimum of matter associated with a maximum of energy; and solids, on the other hand, may be considered to be examples of matter associated with a minimum of energy.

When matter is in the gaseous state, the molecules are very largely under the control of energy, and consequently gases partake more of the nature of energy than they do of matter, and they may be regarded as a sort of connecting link between matter and energy, which enables us mentally to see energy, somewhat similarly, but not exactly in the same way as dust in our atmosphere renders the radiation of energy from the sun ocularly visible.

After the gaseous stage of matter has been reached additional energy can be imparted to it, but in all probability there is a limit to which energy can be imparted to gaseous matter; the absolute zero of temperature would be reached when the ultimate atoms of matter actually touch one another, and the molecules are consequently incapable of further contraction—and the highest degree of temperature theoretically obtainable would result from the temperature being great enough to break up the molecules into their individual atoms.

Now what it is wanted to emphasise is that the molecules of matter, whether they be in the solid, the liquid, or the gaseous condition, do not lose their distinctive properties, a molecule of matter is as complete a system as a mass of matter, and it has precisely the same weight whether it be in the gaseous or in the solid state; and further, weight is the equivalent of the attraction subsisting between matter and matter, and therefore a convertible term for the attractive force it possesses.*

If gaseous matter be confined in an airtight chamber, placed in a room kept at uniform temperature, the energy and the matter which together constitute the gas are definite quantities, and there is no power within the gas itself to increase its energy.

Now according to theory the molecules of gas bombard one another, and when the molecules approach near together repulsion is set up; now we know, as a matter of fact, that molecules attract one another, and that being so, how is it possible for them to repel one another? and further, we also know that when matter collides with matter a transformation of energy to a greater or less degree always occurs; drop a marble on to a hard stone and it oscillates up and down, sensible heat being developed at each impact, the amplitude of each successive oscillation becoming less than that of the preceding one.

It seems absolutely impossible for molecules to bombard one another without parting with energy; the theory assumes, first, that the molecules rush towards one another, and notwithstanding that there is absolute evidence that molecules attract one another, that when they have approached nearer to the sphere of mutual attraction a repulsive force becomes set up; and further, the theory assumes that molecules can jostle against one another without encountering friction or expending energy. The writer himself considers it would be more rational to assume that gases in a confined space exert pressure on the walls of the chamber, much in the same way as metal springs would, only much more perfectly, as gaseous springs exert a uniform pressure in every direction in straight lines radiating from the centres of the molecules.

What has been said above in respect to the theory of gases does not pretend to be any more than common sense reasoning based upon material observations; but it is contended that if the premises be sound, the deductions logically deduced from them must also be correct.

Mr. Crookes's experiments enable physicists to study the behaviour of energy and matter under conditions which previous to his researches were not possible; but the writer must be forgiven for saying that he cannot help thinking that these researches of Mr. Crookes—so original as well as so beautiful—do not seem to have enabled him to amend a theory which does violence to one's common sense. Mr. Crookes talks of *radiant* matter and *ultra*-gaseous matter; in other words, of matter which is not matter, and, presumably, of energy which is not energy. He also talks of atoms "charged with *additional* equivalents of positive or negative electricity, which they carry about as a ship carries its cargo;" and he goes on to say: "We are not concerned with the inherent electricity of which we are ignorant—but with the extra or 'cargo' charge."

Now, where does Mr. Crookes obtain the electrical cargo with which he loads his atomic ships, if there be anything electricians are agreed upon, it is that you can neither add to nor take from the electricity of matter—energy can be stored in matter, but not so electricity, which enters into the constitution of matter.

Certain of our physicists would seem to regard the human intellect as being trandescendentally higher than mere physical nature, and to have become so mentally exalted as to have altogether outgrown common sense; such physicists as these would seem to consider mental assumptions as being sounder crutches to lean upon than material observations.

It may be a low ambition, but the writer has always felt that he would prefer to be an honest cabbage or a good sound potato, rather than one of those freaks of vegetable nature so interesting to botanists, but which are poisonous to eat, and only flourish in a special temperature and a special atmosphere.

It is proposed to make a few general remarks on Mr. Crookes's experiments, avoiding as much as possible anything of the nature of criticism. All physical acts involve matter and energy, and consequently motion, and wherever there is motion there is a transmission of energy, and the experiments of Mr. Crookes are all of them examples of a transmission of energy, the energy being supplied by an induction coil and acting upon the molecules enclosed in the more or less exhausted bulbs and tubes.

Energy can be transmitted mechanically in two ways, (1) by bodily motion, as is the case when a bullet is discharged from a rifle, (2) by molecular transmission of energy, as is the case when a billiard ball is propelled against a row of similar balls touching one another, the energy being transmitted through all of them to the last one of the row, which becomes set into bodily motion, the rest of the balls remaining in a condition of rest.

Energy can be transmitted electrically in two ways, also (1) by bodily motion (2) by conduction, as it is termed, *i.e.*, atomic transmission as distinguished from molecular transmission. We have examples of atomic transmission of energy in the case of lightning discharges, electrolysis, and the transmission of energy through dynamo circuits—in a lightning discharge the air molecules are broken up into their constituent atoms, which immediately afterwards become aggregated into fresh molecules, precisely the same action takes place when, say, a platina wire is disrupted by a powerful Leyden battery discharge, and in the case of ordinary dynamo transmission the mode of transmission is the same, but the energy transmitted is not sufficient to break down the molecular structure as a whole.

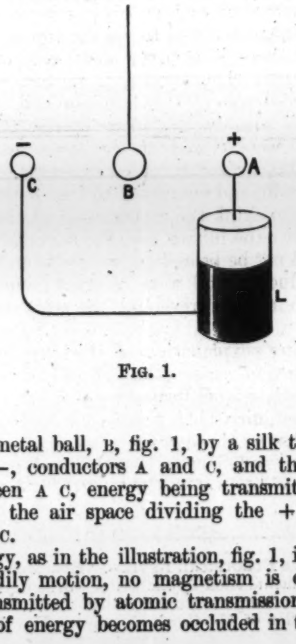


FIG. 1.

Suspend a metal ball, B, fig. 1, by a silk thread between the + and −, conductors A and C, and the ball, B, will oscillate between A C, energy being transmitted by bodily motion across the air space dividing the + and − conductors A and C.

When energy, as in the illustration, fig. 1, is being transmitted by bodily motion, no magnetism is developed, but when it is transmitted by atomic transmission (conduction) a percentage of energy becomes occluded in the conducting chains, and remains occluded during the whole time, energy being transmitted; and magnetism corresponding to such occluded energy is developed in the conductor.

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* Weight is also the equivalent of the inertia which matter opposes.

In certain of the experiments exhibited by Mr. Crookes the energy is transmitted through the partially exhausted tubes by conduction, and in certain of them by bodily motion.

In the "idle pole" phenomena, it is considered, energy is being transmitted bodily and therefore the direction in which the molecules become electrified, or in which current is developed through them, may be said to depend upon accidental circumstances, and there does not seem to be much mystery in the matter.

In the experiment (fig. 9 in Mr. Crookes's address *), in which there are two negative poles and two parallel streams of molecules similarly electrified, Mr. Crookes seems to think that they would attract one another "were the velocity of the streams of molecules greater than that of light," similarly as conductors transmitting energy parallelly and in the same direction; the writer is unable to see how a difference of speed should determine whether similarly electrified molecules repel or attract one another. When energy is transmitted bodily, the molecules act similarly as carriers, but in the case of conduction, work has to be performed in the conductor, inertia is encountered at the time the circuit is closed, similarly as inertia is encountered in the act of setting up bodily motion mechanically, or, to speak more correctly, before energy can be transmitted a percentage of energy has to be occluded, which performs work *after*, but not before the circuit is opened.

Mr. Crookes's experiments, in the writer's case, strengthen certain views he has held for some time, but which he has not yet had the opportunity of verifying, and therefore they are still to a certain extent speculative, and he does not propose to dwell upon them further than he feels he may safely go; the writer arrives at the conclusion that when you statically charge a conductor + you impart energy to it, and when you charge it — you abstract energy; but whether this adds to the temperature in the one ease, or whether it abstracts heat in the other, in the absence of experiment he would not like to say, but he believes if brush discharge occurs between two fixed conductors, the + conductor would become hotter than the — one.†

If two conducting wires, which form the poles of a powerful voltaic battery, be placed across each other at about an inch or so from their extremities, the + wire becomes heated beyond the junction to its extreme end, the — wire remaining comparatively cool; the + electrode of an arc light is also hotter than the — one, and it has always seemed to the writer that this observed difference of temperature between the + and — poles deserves study.

Under the heading "Radiant Matter," there is an experiment (fig.‡ 22) which, so far as the explanation given of the phenomena observed, the writer must join issue with, although he is aware it may seem rash on his part to do so.

In the experiment referred to, on the top of the partially exhausted bulb there is a silver coating, A, of considerable surface on the outer side, forming a mirror, which is connected with the — pole of the induction coil. In the centre of the bulb, and also in the focus of the mirror, there is mounted carbon wool, C, and at the lower end of the bulb there is a metallic surface, B, of considerable extent on the outside of the bulb, and connected to the + pole. Now, the writer ventures to think the carbon wool would be heated all the same, whether the mirror were flat or convex, and the carbon wool would *not* be heated to so great an extent if the poles of the induction coil were reversed; but if the matter in the bulb were radiant, reversing the poles should make no difference.

Now, the writer's explanation of this very pretty experiment is that current passes through the thin glass of the bulb, and the carbon wool forms the + electrode of an electric arc, the silver mirror being the — electrode; the quantity of electricity passing through the glass is, of course, exceedingly minute, but sufficient to heat the wool, and he does not think that the existence of radiant matter is demonstrated by this experiment.

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* See last week's ELECTRICAL REVIEW.—EDS. ELEC. REV.

† Some experiments tried by the writer thirteen years ago seemed to indicate that the temperature was actually reduced.

‡ See continuation of Mr. Crookes's paper.—EDS. ELEC. REV.

THE INFLUENCE OF TEMPER ON THE ELECTRICAL RESISTANCE OF STEEL.

A PAPER, by Mons. H. Le Chatelier, on the above subject was read on January 5th, at the weekly meeting of the Paris Academy of Science, from which we make the following abstract:

The influence of temper upon the character of steel is much greater than has hitherto been supposed. Not only is that character modified as regards internal structure (mechanically) it is also influenced chemically, and as regards its electrical resistance, though this latter influence must be referred to the condition of its internal structure.

The study of these modifications is necessarily rather complicated, as it is difficult to isolate the two orders of phenomena, the one from the other.

Mons. Osmond has investigated the chemical state of steel, and has examined the influence exerted by the presence of carbon upon that state. Following in the same line of investigation Mons. Le Chatelier now examines the variations in the property of electrical resistance.

The experiments were made upon wires 2 millimetres in diameter, and 100 millimetres in length.

The following table gives the resistance in ohms, as well as the value in carbon, of the samples of steel examined, the values given being referred to a piece of wire 1 millimetre long and 1 millimetre in diameter.

	(1)		(2)		(3)		(4)
Resistance ...	0^{ω}·190	...	0^{ω}·250	...	0^{ω}·270	...	0^{ω}·22
Carbon ...	0^{ω}·085	...	0^{ω}·485	...	0^{ω}·670	...	0^{ω}·83

The wire was heated and the resistance measured for various temperatures.

An increase in electrical resistance is produced at a certain well-defined temperature only: it is sharp and does not increase according as the temperature is raised.

The following table exhibits the mean of the temperature of temper obtained by re-heating and re-cooling, the resistance being expressed in the function of its initial value before tempering.

Temperature	750°	...	745°	...	725°	...	735°
Resistance	1·13	...	1·18	...	1·55	...	1·60

In these experiments it was noticed that fragility is developed at the same time as the electric resistance increases, and the temperature of temper is about that of the transformation of carbon, namely 730°.

These results confirm the theory formulated by M. Osmond, namely, that tempering has the effect of preserving at the ordinary temperature the molecular state of carburetted iron, which normally is only stable at about 730°. They do not, however, support the theory that tempering maintains a portion of the iron in that molecular condition which is stable at about 850°.

These experiments show further that in soft steel tempering, provided that it does not produce fragility, impedes the transformation of the carbon as completely as in the case of hard steel.

When steel is re-heated, the electric resistance decreases at a rate which is much greater as the temperature of reheating is more elevated and its action more prolonged. It seems that for each temperature there exists a certain limiting state which can only be attained in an infinite period of time but which is almost reached in a very short time.

The following table gives the resistances of a sample of steel (No. 3) tempered in water at 10° and then heated for periods of one minute at increasing temperatures.

Temperature	10°	120°	205°	310°	385°	450°	550°
Resistance	1·55	1·47	1·29	1·15	1·10	1·07	1·04

The results obtained by tempering steel in baths at increasing temperatures are, from the point of view of electrical resistance, analogous to those which are obtained by tempering at a low temperature and annealing at the temperature of the bath.

If the variation of the electrical resistance be followed during the tempering it is seen that equilibrium of temperature is very rapidly established and the state of the wire remains stationary for a time which varies from a few seconds to several minutes according to the temperature and the nature of the steel. Annealing commences sharply and continues at a rate which rapidly decreases.

Experiments were also made by tempering steel heated between 800° and 900° in baths of variable temperature, maintaining the sample for one minute in the bath, allowing it to finish cooling in the air and then observing its electrical resistance.

Mons. Le Chatelier considers that this first series of experiments shows that the measurement of the electrical resistances permits of the recognition of the state in which the carbon exists in the iron and also enables the observer to estimate the proportion of it that is transformed in tempered steel. He intends to pursue his researches into the mechanical properties of steel by this method and will endeavour to formulate some laws.

PROGRESS OF THE ELECTRICAL INDUSTRIES.

(Continued from page 51).

MESSRS. AUSTIN & MYERS.

Mr. H. Austin, who started business as a manufacturing electrician at Armley, near Leeds, not very many months ago, informs us that he has been very successful with his "Infant" dynamo. Judicious advertising has brought him orders and enquiries, not only from various parts of the United Kingdom, but also from France, Holland, Germany, Belgium, Italy, Spain, Russia, China, Africa, India, America, and Australia. His premises have been extended and he has taken as partner Mr. Myers, who, by taking charge of the mechanical department of the business, will enable Mr. Austin to devote more attention to the electrical details.

THE BRIGHTON ELECTRIC LIGHT COMPANY

have been struggling against the threatened competition of the Corporation of Brighton, and have adopted the bold policy of cutting off any consumers who will not sign a three years agreement with them. About three-quarters of their customers have agreed to this, so it would seem that their policy may be successful.

CROMPTON AND CO.

The output of this company in all classes of work has been about double what it was the preceding year. The heaviest portion of the work has, of course, been in connection with central stations, of which we may name the Kensington and Knightsbridge, the Notting Hill and the Westminster Companies in London; the Birmingham Electric Supply Company; Northampton, Southampton, Chelmsford, Swansea, and other towns. The company have increased the number of mains laid on the Crompton culvert system, until at the present time there is nearly 100 miles either in use or ready for use. Messrs. Crompton & Co. executed a contract for an electric railway for the Southend Local Board, in a remarkably short space of time, in the course of last summer. The line has been working ever since, and has given very great satisfaction, and is, we believe, a very paying investment for the Local Board. Great strides have been made in the manufacture of dynamo machines. The average of three 200 H.P. machines recently supplied to the Birmingham Company has shown a commercial efficiency reaching 96 per cent., which the firm believe is a record of the highest results obtained by any makers. The extremely high efficiencies obtained by them and other makers are supposed to be principally due to the use of the patent twisted and compressed copper strand armature conductors. Most of the leading firms are licensed by Messrs. Crompton & Co. to use this invention, and in every case they have found enormously increased efficiency from the use of it. They have made a great many sets of electrical transmission plant for pumping and haulage in collieries. This company have been surprised to find that they are able to compete with American manufacturers of electrical machinery on their own ground, and have sent out a good many sets of machinery to that country, although they have to pay a 45 per cent. import duty. As regards the foreign business, the Australian Company is very full of orders. One of the managing directors, Mr. Albright, is visiting that country, and hopes to secure the lighting of some of the largest towns, as the company have already lighted some of the smaller ones. The increasing difficulty of obtaining accurate tests of the various materials used in the business, led Mr. Crompton to establish a very complete testing laboratory at Kensington. This is fitted with large accumulators, and all kinds of apparatus for the testing of copper and iron, and the efficiency of batteries, dynamos, arc lamps, and arc lamp carbons. The great increase of London work has necessitated the building of a factory at Lillie Road, Kensington. These works, which were only started in the summer, have been kept fully employed up to the present, and appear likely to be so for a long time to come. In many cases there are reasons why definite information cannot be given, but we have indicated sufficiently the variety of work carried on by this firm. Thus, in electrical transmission of power, work has been done at Pleasby Colliery, at Southend, at Stanton Iron Works, and we hope to see this class of work extend in the near future very largely. Electric lighting has been carried out on a large scale from various central stations, and a considerable number of private installations.

THE EASTBOURNE ELECTRIC LIGHT COMPANY

continue to develop their high-tension alternate current system of distribution, and, like many other companies, find they cannot cope with the demand for light. They are putting down another Elwell-Parker 70-kilowatt alternate current dynamo, and another high-pressure locomotive type boiler. About 5,000 lamps are in use. The mains, as is well known, are all underground, and have given no trouble except at some of the joints, which were rubber-covered and then coated with gutta-percha. A few bad joints have since been vulcanised, and Mr. H. W. Wilkinson, the engineer, anticipates no further difficulty. The sliding-scale system is about to make way for a uniform charge of tenpence per kilowatt hour.

THE EXETER ELECTRIC LIGHT COMPANY

has only just begun to supply power. The whole work was carried out during last year. Two Mordey 75-kilowatt alternators are used, and two Thomson-Houston 30-light arc machines. Two Fowler compound horizontal and two Westinghouse 25 horse-power engines are used, with Babcock and Willcox boilers. Space is left for two more large engines and the necessary dynamos. The wiring is overhead, and where it crosses a street a No. 10 steel wire is arranged above to act as a safety guard. The whole is in charge of Mr. T. P. Wilmshurst.

MESSRS. HAMMOND AND COMPANY

are carrying out some very extensive central station work in Madrid. They have just completed a central station there of the same type as that at West Brompton, but twice as large. There is a specially good opening for central station work in Spain, for gas is dear.

J. H. HOLMES AND COMPANY,

of Newcastle-on-Tyne, have been kept extremely busy throughout the year, their output in dynamos being about double that of any previous year. They have sold during that period 152 dynamos having an average output at usual speeds of 18,000 watts each, or equal to maintaining, say, 45,000 glow lamps of 16 C.P. The demand for these machines has increased so rapidly that, although the works have doubled in size during the year, the firm have been obliged to decline some urgent orders. Messrs. J. H. Holmes and Co. have, in addition to supplying other electrical engineers with dynamos, completed 66 installations of electric light in mills, factories, residencies, steamships, &c.

THE LIVERPOOL ELECTRIC SUPPLY COMPANY

have during the last twelve months increased their supply from six to ten thousand 16-candle lamps. They have now three central stations in operation, and a complete system of underground mains. A continuous supply at 110 volts is kept on day and night. The electric light is very highly appreciated in Liverpool.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers. Thursday, January 15th, 1891.

ADDRESS OF THE PRESIDENT, WILLIAM CROOKES, F.R.S.

ELECTRICITY *IN TRANSITU*: FROM PLENUM TO VACUUM.

(*Continued from page* 81.)

PROPERTIES OF RADIANT MATTER.

One of the most characteristic attributes of radiant matter—whence its name—is that it moves in approximately straight lines, and in a direction almost normal to the surface of the electrode. If we keep the induction current passing continuously through a vacuum tube in the same direction, we can imagine two ways in which the action proceeds; either the supply of gaseous molecules at the surface of the negative pole must run short, and the phenomena come to an end, or the molecules must find some means of getting back. I will show you an experiment which reveals the molecules in the very act of returning. Here is a tube (fig. 14) exhausted to a pressure of 0·001 mm. or 1·3 M. In the middle of the tube is a thin glass diaphragm, C, pierced with two holes, D and E. At one part of the tube a concave pole, A′, is focussed on the upper hole, D, in the diaphragm. Behind the upper hole and in front of the lower one are movable vanes, F and G, capable of rotation by the slightest current of gas through the holes.

On passing the current with the concave pole negative, the small vanes rotate in such a manner as to prove that at this high exhaustion a stream of molecules issues from the lower hole in the diaphragm, whilst at the same time a stream of freshly charged molecules is forced by the negative pole through the upper hole. The experiment speaks for itself, showing as forcibly as an experiment can show that so far the theory is right.

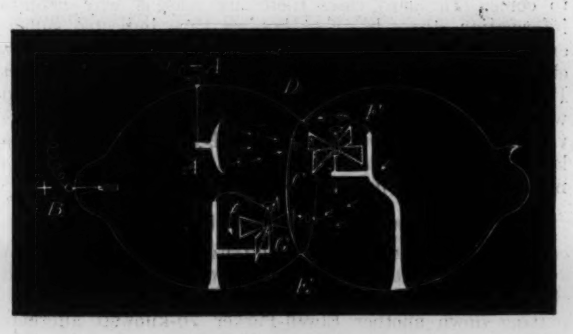

FIG. 14.—P = 0·001 mm. = 1·3 M.

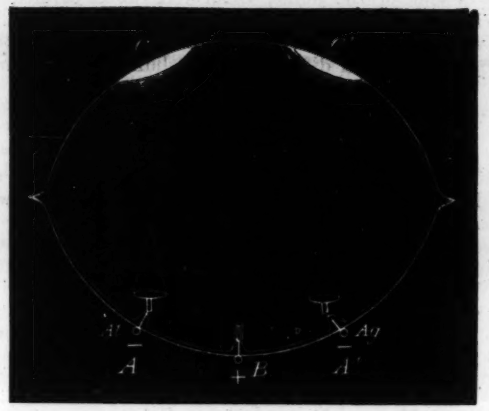

FIG. 15.—P = 0·00068 mm. = 0·9 M.

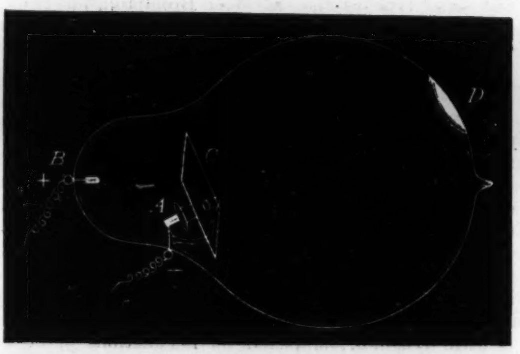

FIG. 16.—P = 0·00068 mm. = 0·9 M.

This view of the ultra-gaseous state of matter is advanced merely as a working hypothesis, which, in the present state of our knowledge, may be regarded as a necessary help to be retained only so long as it proves useful. In experimental research early hypotheses have necessarily to be modified, or adjusted, or perhaps entirely abandoned, in deference to more accurate observations. Dumas said, truly, that hypotheses were like crutches which we throw away when we are able to walk without them.

RADIANT MATTER AND "RADIANT ELECTRODE MATTER."

In recording my investigations on the subject of radiant matter and the state of gaseous residues in high vacua under electrical strain, I must refer to certain attacks on the views I have propounded. The most important of these questionings are contained in a volume of "Physical Memoirs," selected and translated from foreign sources under the direction of the Physical Society (vol. i., Part 2). The volume contains two memoirs, one by Hittorff on the "Conduction of Electricity in Gasses," and the other by Puluj on "Radiant Electrode Matter and the So-called Fourth State." Dr. Puluj's paper concerns me most, as the author has set himself vigorously to the task of opposing my conclusions. Apart from my desire to keep controversial matter out of an address of this sort, time would not permit me to discuss the points raised by my critic; I will therefore only observe in passing that Dr. Puluj has no authority for linking my theory of a fourth state of matter with the highly transcendental doctrine of four dimensional space.

Reference has already been made to the mistaken supposition that I have pronounced the thickness of the dark space in a highly exhausted tube, through which an induction spark is passed, to be identical with the natural mean free path of the molecules of gas at the exhaustion. I could quote numerous passages from my writings to show that what I meant and said was the mean free path as amplified and modified by the electrification* In this view I am supported by Prof. Schuster,† who in a passage quoted below distinctly admits that the mean free path of an electrified molecule may differ from that of one in its ordinary state.

The great difference between Puluj and me lies in his statement that‡ "*the matter which fills the dark space consists of mechanically detached particles of the electrodes which are charged with statical negative electricity, and move progressively in a straight direction.*"

To these mechanically detached particles of the electrodes, of different sizes, often large lumps "§ Puluj attributes all the phenomena of heat, force and phosphorescence that I from time to time have described in my several papers.

Puluj objects energetically to my definition "Radiant Matter," and then proposes in its stead the misleading term, "Radiant Electrode Matter." I say "misleading," for while both his and my definitions equally admit the existence of "Radiant Matter," he drags in the hypothesis that the radiant matter is actually the disintegrated material of the poles.

Puluj declares that the phenomena I have described in high vacua are produced by his irregularly shaped lumps of Radiant Electrode Matter. My contention is that they are produced by Radiant Matter of the residual molecules of gas.

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* "The thickness of the dark space surrounding the negative pole is the measure of the mean length of the path of the gaseous molecules between successive collisions. The electrified molecules are projected from the negative pole with enormous velocity, varying, however, with the degree of exhaustion and intensity of the induction current."—(*Phil. Trans.*, Part i., 1879, par. 530).

"The extra velocity with which the molecules rebound from the excited negative pole keeps back the more slowly moving molecules which are advancing towards the pole. The conflict occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the discharge."—(*Phil. Trans.*, Part i., 1879, par. [illegible])

"Here, then, we see the induction spark actually illuminating the lines of molecular pressure caused by the excitement of the negative pole."—(R. I. Lecture, Friday, April 4th, 1879.)

"The electrically excited negative pole supplies the *force majeure* which entirely, or partially, changes into a rectilinear action the irregular vibration in all directions."—*Proc. Roy. Soc.*, 1880, page [illegible]

"It is also probable that the absolute velocity of the molecules is increased so as to make the mean velocity with which they leave the negative pole greater than that of ordinary gaseous molecules."—*Phil. Trans.*, Part ii., 1881, par. 719.)

† "It has been suggested that the extent of the dark space represents the mean free path of the molecules. . . . It has been pointed out by others that the extent of the dark space is really considerably greater than the mean free path of the molecules, calculated according to the ordinary way. My measurements make it nearly 20 times as great. This, however, is not in itself a fatal objection; for, as we have seen, the mean free path of an ion may be different from that of a molecule moving among others."—Schuster, *Proc. Roy. Soc.*, xlvii., pp. 556-7.

‡ "Physical Memoirs," Part ii., vol. 1., page 244. The paragraph is italicised in the original.

§ *Loc cit.*, p. 242.

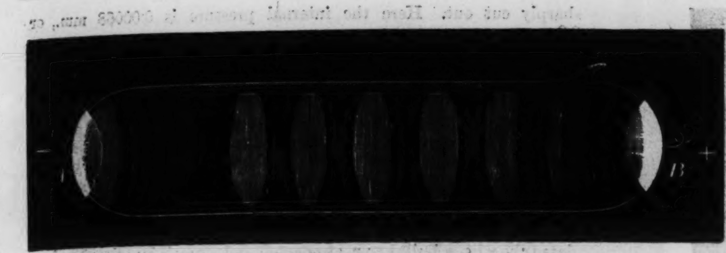

FIG 17.—P = 2·0 mm.

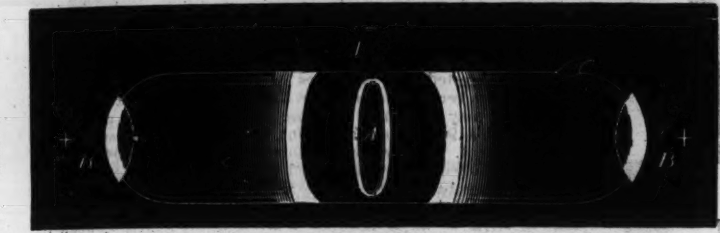

FIG. 18.—P = 0·076 mm. P = 100·0 M.

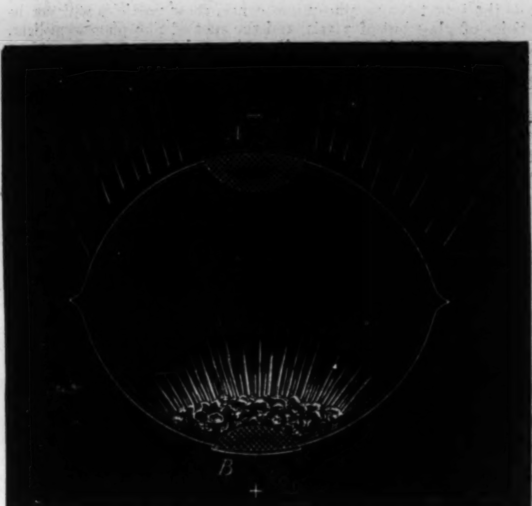

FIG. 19.—P = 0·00068 mm. = 0·9 M.

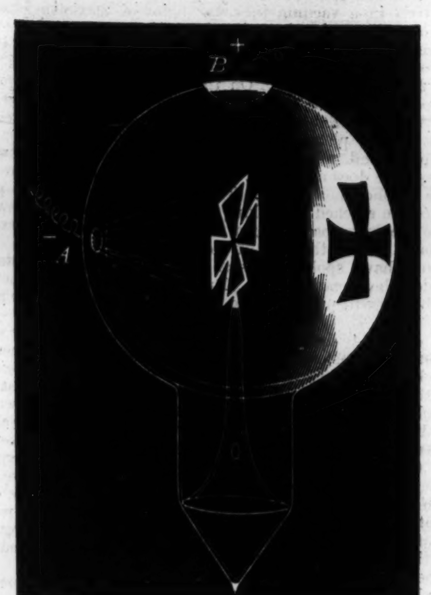

FIG. 20.—P = 0·00068 mm. = 0·9 M.

Were it not that in this case we can turn to experimental evidence I would not mention the subject to you. On such an occasion as this controversial matter must have no place; therefore I content myself, at present, by showing a few novel experiments which demonstratively prove my case.

Let me first deal with the Radiant Electrode hypothesis. Some metals it is well-known, such as silver, gold, or platinum, when used for the negative electrode in a vabuum tube, volatilise more or less rapidly, coating any object in their neighbourhood with a very even film. On this depends the well-known method of electrically preparing small mirrors, &c. Aluminium, however, seems exempt from this volatility. Hence, and for other reasons, it is generally used for electrodes.

If, then, the phenomena in a high vacuum are due to the "electrode matter," the more volatile the metal used the greater shall be the effect*.

Here is a tube (Fig. 15, P = 0·00068 mm., or 0·9 M.), with two negative electrodes, A, A′, so placed as to project two luminous spots on the phosphorescent glass of the tube. One electrode, A′, is of pure silver, a volatile metal, the other, A, is of aluminium, practically non-volatile. A quantity of "electrode matter" will be shot off from the silver pole and practically none from the aluminium pole; but you see that in each case the phosphorescence, C, C′, is identical. Had the Radiant Electrode Matter been the active agent the more intense phosphorescence would proceed from the more volatile pole.

A drawing of another experimental piece of apparatus is shown in fig. 16. A pear-shaped bulb of German glass has near the small end an inner concave negative pole, A, of pure silver so mounted that its inverted image is thrown upon the opposite end of the tube. In front of this pole is a screen of mica, C, having a small hole in the centre so that only a narrow pencil of rays from the silver pole can pass through, forming a bright spot, D, at the far end of the bulb. The exhaustion is about the same as in the previous tube, and the current has been allowed to pass continuously for many hours so as to drive off a certain portion of the silver electrode, and upon examination it is found that the silver has all been deposited in the immediate neighbourhood of the pole, whilst the spot, D, at the far end of the tube that has been continuously glowing with phosphorescent light, is practically free from silver.

The experiment is too lengthy for me to repeat it here, so I shall not attempt it, but I have on the table the results for examination.

The identity of action of silver and aluminium in the first case, and the non-projection of silver in this second instance, in themselves are sufficient to condemn Dr. Puluj's hypothesis, since they prove that phosphorescence is independent of the material of the negative electrode. In front of me is a set of tubes that to my mind puts the matter wholly beyond doubt. The tubes contain no inside electrodes with the residual gaseous molecules, and with them I will proceed to give some of the most striking radiant matter experiments without any inner metallic poles at all.

In all these tubes the electrodes, which are of silver, are on the outside, the current acting through the body of the glass. The first tube contains gas only slightly rarefied and at the stratification stage. It is simply a closed glass cylinder, with a coat of silver deposited outside at each end, and exhausted to a pressure of 2 mm. The outline of the tube is shown in fig. 17. I pass a current and, as you see, the stratifications, though faint, are perfectly formed.

The next tube, seen in outline in fig. 18, shows the dark space. Like the first it is a closed cylinder of glass, with a central indentation forming a kind of hanging pocket, and almost dividing the tube into two compartments. This pocket, silvered on the air side, forms a hollow glass diaphragm that can be connected electrically from the outside, forming the negative pole, A; the two ends of the tube, also outwardly silvered, form the positive poles, B, B. I pass the current and you all see the dark space distinctly visible. The pressure here is 0·076 mm., or 100 M.

The next stage, dealing with more rarefied matter, is that of phosphorescence. Here is an egg-shaped bulb, shown in fig. 19, containing some pure yttria, and a few rough rubies. The positive electrode, B, is on the bottom of the tube under the phosphorescent material; the negative, A, is on the upper part of the tube. See how well the rubies and yttria phosphoresce under molecular bombardment, at an internal pressure of 0·00068 mm., or 0·9 M.

A shadow of an object inside a bulb can also be projected on to the opposite wall of the bulb by means of an outside pole. A mica cross is supported in the middle of the bulb (fig. 20), and on connecting a small silvered patch, A, on one side of the bulb with the negative pole of the induction coil, and putting the positive pole to another patch of silver, B, at the top, the opposite side of the bulb glows with a phosphorescent light, on which the black shadow of the cross seems

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* In a valuable paper read before the Royal Society, November 20th, 1890, by Professors Liveing and Dewar, on finely divided metallic dust thrown off the surfaec of various electrodes in vacuum tubes, they find not only that dust, however fine, suspended in a gas will not act like gaseous matter in becoming luminous with its characteristic spectrum in an electric discharge, but that it is driven with extraordinary rapidity out of the course of the discharge.

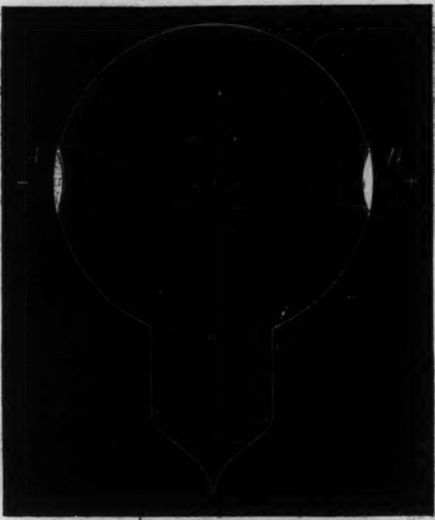

FIG. 21.—P = 0·001 mm. = 1·3 M.

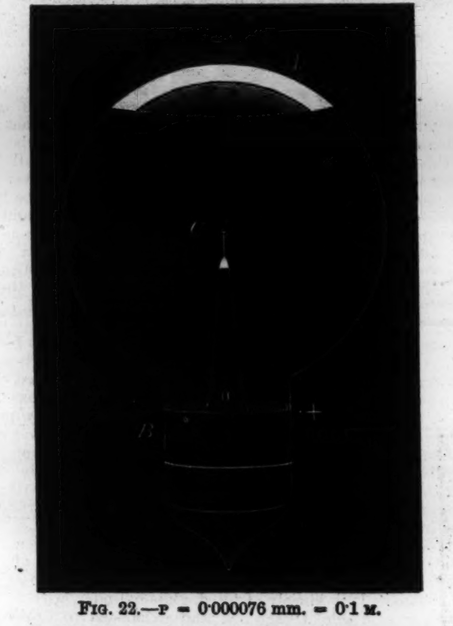

FIG. 22.—P = 0·000076 mm. = 0·1 M.

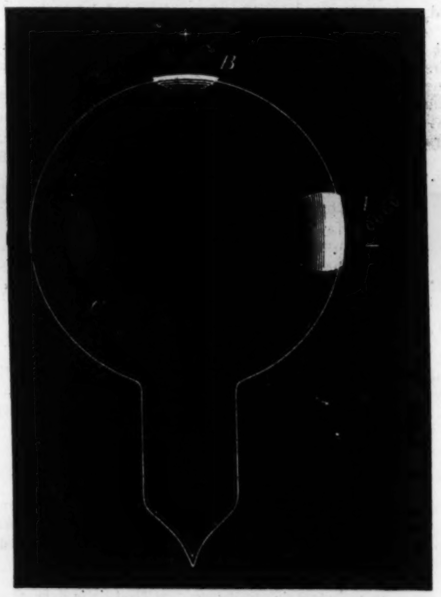

FIG. 23.—P = 0·00068 mm. = 0·9 M.

sharply cut out. Here the internal pressure is 0·00068 mm., or 0·9 M.

Passing to the next phenomenon, I proceed to show the production of mechanical energy in a tube without internal poles. It is shown in fig. 21 (P = 0·001 mm., or 1·3 M.) It contains a light wheel of aluminium, carrying vanes of transparent mica, the poles, A, B, being in such a position outside that the molecular focus falls upon the vanes on one side only. The bulb is placed in the lantern, and the image is projected on the screen; if I now pass the current you see the wheel rotates rapidly, reversing in direction as I reverse the current.

Here is an apparatus, fig. 22, which shows that the residual gaseous molecules when brought to a focus produce heat. It consists of a glass tube with a bulb blown at one end and a small bundle of carbon wool, C, fixed in the centre, and exhausted to pressure of 0·000076 mm., or 0·1 M. The negative electrode, A, is formed by coating part of the outside of the bulb with silver, and it is in such a position that the focus of rays falls upon the carbon wool. The positive electrode, B, is an outer coating at the other end of the tube. I pass the current, and those who are close may see the bright sparks of carbon raised to incandescence by the impact of the molecular stream.

You thus have seen that all the old "radiant matter" effects can be produced in tubes containing no metallic electrodes to volatilise. It may be suggested that the sides of the tube in contact with the outside poles become electrodes in this case, and that particles of the glass itself may be torn off and projected across, and so produce the effects. This is a strong argument, which fortunately can be tested by experiment. In the case of this tube (fig. 23, P = 0·00068 mm., or 0·9 M) the bulb is made of lead glass phosphorescing blue under molecular bombardment. Inside the bulb, completely covering the part that would form the negative pole, A, I have painted a substantial coat of yttria, so as to interpose a layer of this earth between the glass and the inside of the tube. The negative and positive poles are silver discs on the outside of the bulb, A being the negative and B the positive pole. If, therefore, particles are torn off and projected across the tube to cause phosphorescence, these particles will not be particles of glass but of yttria, and the spot of phosphorescent light, C, on the opposite side of the bulb will not be the dull blue of lead glass, but the golden yellow of yttria. You see there is no such indication; the glass phosphoresces with its usual blue glow, and there is no evidence that a single particle of yttria is striking it.

Witnessing these effects I think you will agree I am justified in adhering to my original theory that the phenomena are caused by the radiant matter of the residual gaseous molecules, and certainly not by the torn off particles of the negative electrode.

PHOSPHORESCENCE IN HIGH VACUA.

I have already pointed out that the molecular motions rendered visible in a vacuum tube are not the motions of molecules under ordinary condition, but are compounded of these ordinary or kinetic motions, and the extra motion due to the electrical impetus.

Experiments show that in such tubes a few molecules may traverse more than a hundred times the *mean* free path, with a correspondingly increased velocity, until they are arrested by collisions. Indeed, the molecular free path may vary in one and the same tube, and at one and the same degree of exhaustion.

Very many bodies, such as ruby, diamond, emerald, alumina, yttria, samaria, and a large class of earthy oxides and sulphides, phosphoresce in vacuum tubes when placed in the path of the stream of electrified molecules proceeding from the negative pole. The composition of the gaseous residue present does not affect phosphorescence; thus, the earth yttria phosphoresces well in the residual vacua of atmospheric air, of oxygen, nitrogen, carbonic anhydride, hydrogen, iodine, sulphur, and mercury.

With yttria in a vacuum tube, the point of maximum phosphorescence, as I have already pointed out, lies on the margin of the dark space. The diagram, fig. 24, shows approximately the degree of phosphorescence in different parts of a tube at an internal pressure of 0·25 mm., or 330 M. On the top you see the positive and negative poles, A and B, the latter having the outline of the dark space shown by a dotted line, C. The curve, D, E, F, shows the relative intensities of the phosphorescence at different distances from the negative pole, and the position inside the dark space at which phosphorescence does not occur. The height of the curve represents the degree of phosphorescence. The most decisive effects of phosphorescence are reached by making the tube so large that the walls are outside the dark space, whilst the material submitted to experiment is placed just at the edge of the dark space.

Hitherto I have spoken only of phosphorescence of substances placed under the negative pole. But from numerous experiments I find that bodies will phosphoresce in actual contact with the negative pole.

This is only a temporary phenomenon, and ceases entirely when the exhaustion is pushed to a very high point. The experiment is one scarcely possible to exhibit to an audience, so I must content myself with describing it. A U-tube, shown in fig. 25, has a flat aluminium pole, in the form of a disc, at each end, both coated with a paint of phosphorescent yttria. As the rarefaction approaches about 0·5 mm. the surface of the negative pole, A, becomes faintly phosphorescent. On continuing the exhaustion this luminosity rapidly diminishes, not only in intensity, but in extent, contracting more and more from the edge of the disc, until ultimately it is visible only as a bright spot in the centre. This fact does not prop a recent theory, that as the exhaustion gets higher the discharge leaves the centre of the pole, and takes place only between the edge and the walls of the tube.

If the exhaustion is further pushed, then at the point where the surface of the negative pole ceases to be luminous, the material on the positive pole, B, commences to phosphoresce, increasing in intensity

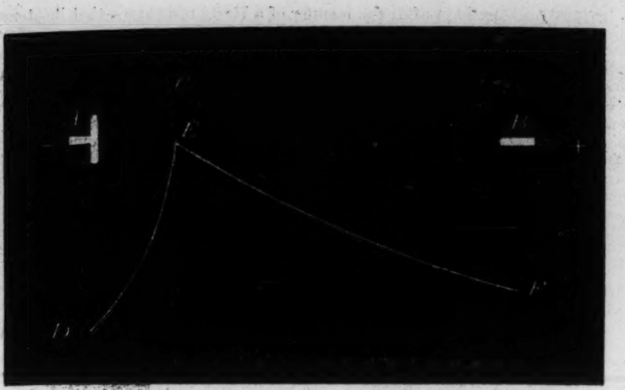

FIG. 24.—P = 0·25 mm. = 330·0 M.

FIG. 25.

P = 0·076 mm. = 100·0 M.

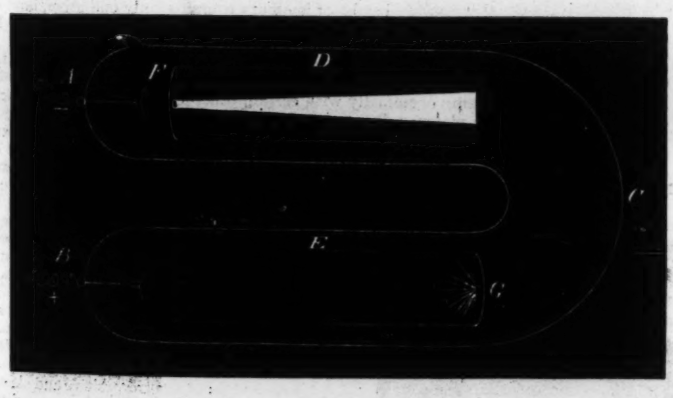

FIG. 26.—P = 0·000076 mm. = 0·1 M.

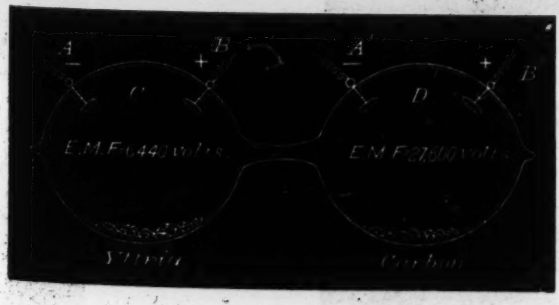

FIG. 27.—P = 0·02 mm. = 26·0 M.

until the tube refuses to conduct, its greatest brilliancy being just short of this degree of exhaustion. The probable explanation is that the vagrant molecules I introduce in the next experiment, happening to come within the sphere of influence of the positive pole, rush violently to it and excite phosphorescence in the yttria, whilst losing their negative charge.

LOOSE AND ERRATIC MOLECULES.

In the brief time left to me this evening I cannot touch upon the mass of experiments made to render this result clear, so I will at once show you a piece of apparatus that clearly illustrates the cause of phosphorescence at the positive pole. A drawing of this tube is shown at Fig. 26, but let me first explain the effect I expect to obtain, and then endeavour to show the actual experiment.

A C B is a U-shaped tube with terminals, A and B, at each end; D and E are two mica screens covered with A phosphorescent powder, having at F and G other screens with a small slit in front, so as to allow only a narrow beam of charged molecules to pass through. At first the tube is exhausted to a pressure of 0·076 mm. or 100 M., and you see how sharp and slightly divergent is the luminous image on screen D, whilst not a trace of phosphorescence is to be seen on the screen E in the other limb of the tube. Now I push the exhaustion to the highest point short of non-conduction (0·000076 mm., or 0·1 M.), and the phenomena change. The initial line of light on D becomes wider and unsteady, whilst at the gate, G, a decided phosphorescence is observable entering the second screen, E. This luminosity diverges to a considerable extent, much more than did the stream of charged molecules observed in the first limb of the tube at the lower exhaustion. This is only to be expected, inasmuch as those sparse molecules which have run the gauntlet of the crowd and have been hunted and buffetted round the corner will have little or no lateral support, but wander to the furthest part of the tube, and altogether behave differently to the orderly procession of molecules at more moderate exhaustion.

THE RESISTANCE OF HIGH VACUA.

I must only lightly touch this phenomenon to-night; it is a subject of deep interest, and one to which I have lately devoted much time. Shortly I hope to publish a full account of results recently obtained.

The passage of an induction current at a high vacuum through a tube depends much upon the material of the tube or the substance enclosed within it. Given the same degree of exhaustion, and the same distance between the terminals inside the tube, the E.M.F. necessary to force the current through may vary from 3,000 volts to 20,000 volts, according to the particular material used.

Here is a very striking example that will serve to illustrate this phenomenon. Fig. 27 is a double tube joined by a narrow open channel and therefore in the same state of exhaustion through- out (P = 0·02 mm. or 26 M). Each tube is furnished with a pair of poles, A, B, and A′, B′. One tube contains the phosphorescent earth yttria, the other contains finely divided carbon. I first connect the yttria tube, C, to the coil, and place in parallel circuit with it a spark gauge. To begin with, this gauge is set to a gap of 1 mm. (An E.M.F. of 920 volts is necessary to strike across 1 mm. of air; therefore the difference of potential at the terminals inside the yttra tube is 920 volts, and this you perceive is not sufficient to force the current through the tube). I now gradually open the gauge until the potential of the inner terminals has risen to a point high enough to allow the spark to pass through the tube, making the yttria phosphorescent.

The gap is at 7 mm. equal to an E.M.F. of 6,440 volts. I next attach the coil wires to the tube, D, containing the carbon, and the exhaustion in the tubes being the same as before, I repeat the experiment; you now see that the gap has to be opened to 30 mm., equivalent to an E.M.F. of 27,600 volts, before the current will pass throughthe tube. The fact of whether the vacuum tube contains yttria or carbon makes a difference of 21,160 volts in the E.M.F. required to cause a discharge between the terminals.

One other experiment I would like to show in further illustration of this resistance. The idea suggested itself that possibly differences in the material or conductivity of the particular bulbs might influence the results you have just seen. Here (fig. 28) is a long cylindrical tube of phosphorescent Bohemian glass containing a pair of terminals, A, B; it also contains a shorter cylinder of glass, C, C, brightly silvered inside. The internal pressure is 0·00068 mm., or 0·9 M. The silver cylinder is now at one end of the tube out of the way of the terminals, which therefore have phosphorescent glass around them. I turn on the coil and find that the E.M.F. necessary to force the current through, now that the terminals are in a phosphorescent chamber, is 1,380 volts. I slide the cylinder down to the end of the tube so as to inclose the terminals in a metallic silver chamber, and you see the E.M.F. necessary to pass the current rises to 6,440 volts. Metallic silver does not phosphoresce, whilst Bohemian glass phosphoresces very well. It appears that the greater the phosphorescing power of the substance surrounding the poles so much the easier does the induction spark pass. Surround the poles with Bohemian glass or yttria—two phosphorescent non-conductors of electricity—and the induction spark passes easily; immediately I surround the terminals with a non-phosphorescent conductor the current refuses to pass.

WHAT OCCASIONS PHOSPHORESCENCE?

I should like to interest you in a question that has exercised my mind for some time past. What is it that occasions the phosphorescence of yttria and other bodies in vacuo under molecular bombardment?

So far I have found this phosphorescence to be an attribute of non-conductors only. We know that in the act of phosphorescence the molecules of yttria are in a state of intense vibration. Each molecule may be viewed as the radiating centre of the entire bundle of rays, which, when decomposed by the prism, displays a discontinuous spectrum. We may also suppose that the residual atoms of gas charged with negative electricity give off their electricity on coming in collision with a phosphorescent body and on their return take up a fresh charge.

THE ELECTROLYSIS HYPOTHESIS.

There is a certain amount of evidence in favour of an electrolytic hypothesis of the passage of electricity through rarefied gases. This has been ably advocated by Prof. Schuster in the Bakerian lecture before the Royal Society, March 20th, 1890.[*]

A molecule of hydrogen gas, for instance, may be made up of one group of atoms of hydrogen having an equivalent of negative electricity inherent in it, and one group of atoms having an equivalent of positive electricity bound up with it. These atoms are also charged with *additional* equivalents of positive or negative electricity, which they carry about as a ship carries its cargo. We are not concerned with the inherent electricity—of which we are ignorant—but with the extra or "cargo" charge. Let us imagine a molecule of hydrogen near the face of the negative pole in a vacuum tube. I turn on the current, and the atoms of the hydrogen molecule are dragged apart. The positive atom is attracted to the negative pole, where the violence of impact, or the discharge of electricity, renders it apparent with evolution of light. The internal luminous layer, which is closely adjacent to the negative electrode, is due, therefore, to the positive atoms rushing to the negative pole, and not, like the glow round the edge of the dark space, to the negative atoms projected from it. The negative atom, on the other hand, is driven violently from the negative pole, in virtue of the mutual repulsion existing between any two bodies similarly electrified, with a velocity varying with the intensity of the electrification and the degree of the vacuum; the more perfect the vacuum the greater the velocity, the atoms flying outwards in straight lines until they meet with an obstacle. Such an obstacle may be a procession of positively charged atoms from the positive pole; in this case the two kinds of atoms mutually discharge each other's cargoes with a display of light. This phenomenon occurs at the margin of the dark space when the vacuum is only moderate. Or the obstacle may be produced by the vacuum being so high that the atoms of gas present are too few to form a continuous procession. (*Why* a high vacuum should be non-conductive does not clearly appear, but the fact itself is beyond doubt; it is probably connected with the inability of electrified atoms to leave the poles.) Or again, the obstacle may be a phosphorescent body like yttria. In this case the negatively charged atoms deliver up their charge of electricity to the yttria, which is so constituted—perhaps after the manner of a Hertz resonater—that its atoms charge and discharge, vibrating about 550 billion times in a second, and producing waves in the ether of the length, approximately, of 5·74 ten-millionths of a millimetre, and occasioning in the eye the effect of citron light.

We are not under the necessity of supposing that this number of hydrogen atoms are driven against the yttria in the second, although even at a high vacuum there are quite enough atoms left in the bulb to keep up such a supply. All that is needed is that a succession of shocks, not necessarily rhythmical, may strike the yttria at frequencies which will set up such a number of vibrations, just as a series of slow impacts on a gong causes it to emit sound waves of much greater frequency.

In a low vacuum only very few atoms can run the gauntlet among the crowd of inrushing atoms, and those few which succeed in reaching the yttria arrive with much reduced velocity, and so faint is the phosphorescence they set up that it is completely obscured[*] by the brighter phosphorescence of the residual gas. As the vacuum becomes higher, more and more atoms find their way across, and their speed being at the same time accelerated, the phosphorescence becomes intensified. At a good vacuum most of the atoms hit the yttria, their velocity is increased, and the rhythmical excitation reaches its maximum.

THE DARK SPACE IN MERCURY VAPOUR.

In applying the electrolytic hypothesis, I have used for illustration's sake the gaseous residue of hydrogen, which is known as a diatomic gas. I have found, however, the phenomena of the dark space, &c., to occur in the vapour of mercury, which is a monatomic gas. This important result induced me to patiently investigate this subject, and the result of one experiment is before you, fig. 29. The tube is furnished with aluminium terminals, and is so arranged that the induction spark can be kept passing during exhaustion to drive off occluded gases. When at the highest attainable vacuum, the tube is filled with pure mercury by simply raising a reservoir. On applying heat the entire contents of the tube are boiled away and pass down the fall tubes of the pump, exhaustion going on at the same time. When the whole of the mercury has thus been boiled away *in vacuo*, except a little condensed at the upper part of the tube, the results on passing the spark are as follows:—when the tube is cold the induction current refuses to pass; on gently heating with a gas burner the current passes and the dark space is distinctly visible. Continuing the heat so as to volatilise the drops of mercury condensed on the sides, the whole tube becomes filled with a green phosphorescent light, the dark space gets smaller and smaller, and ultimately the negative pole becomes covered with a luminous glow. On allowing the tube to cool, the same phenomena ensue in inverse order. The luminous halo expands, showing the dark space between it and the pole, and this dark space gradually grows larger as the tube becomes cooler. The mercury again condenses on the side of the tube, the green phosphorescence grows paler and paler, until at last the induction spark from the large coil refuses to pass.

At first sight this result appears fatal to the electrolytic hypothesis, for if the molecule of mercury contains only one atom, how can we talk of its separation into positive and negative atoms by the electric stress? It must be remembered, however, that we are as yet ignorant of the absolute mass of the atom of any element. All that can be said is that a molecule of free hydrogen becomes halved in combining chemically with certain other elements, whilst a molecule of free mercury does not suffer division on yielding any known compound of mercury; the physical atoms in the one behave as two separate groups, and those in the other as one undivided group. It has been agreed by chemists, for simplicity's sake and for facilitating chemical calculations, to reduce the units to the lowest term, consistent with the avoidance of fractions; we therefore say that the atoms in a molecule of free hydrogen act in chemistry as two separate groups, each of a minimum relative weight of 1, whilst those in a molecule of free mercury act as one undivided group of the relative weight 200. But to what number of atoms the 1 and 200 correspond respectively no chemist knows.

To show how intimately chemistry and electricity interlock, I may here remark that one of the latest theories in chemistry renders such a division of the molecule into groups of electro-positive and electro-negative atoms necessary for a consistent explanation of the genesis of the elements. This is so important that I may be excused for digressing a little into this development of theoretical chemistry.

GENESIS OF THE ELEMENTS.

It is now generally acknowledged that there are several ranks in the elemental hierarchy, and that besides the well-defined groups of chemical elements, there are underlying sub-groups. To these sub-groups has been given the name of meta-elements. The original genesis of atoms assumes the action of two forms of energy working in time and space—one operating uniformly in accordance with a continuous fall of temperature, and the other having periodic cycles of ebb and swell, and intimately connected with the energy of elec-

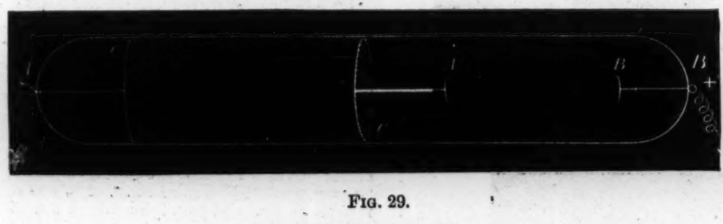

FIG. 29.

P = 0·00068 mm. = 0·9 M

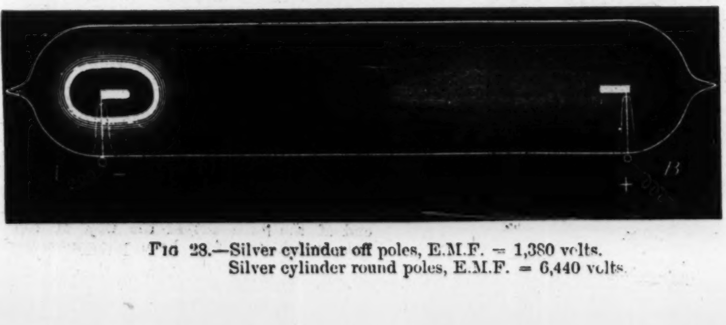

FIG 28.—Silver cylinder off poles, E.M.F. = 1,380 volts.
Silver cylinder round poles, E.M.F. = 6,440 volts.

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[*] *Roy. Soc. Proc.*, xlvii., 526.

[*] This faint phosphorescence at a low vacuum can be rendered visible by the electrical phosphoroscope described in my lecture at the Royal Institution in 1887.

tricity (fig. 30). The centre of this creative force in its journey through space scattered seeds or sub-atoms that ultimately coalesced into the groupings known as chemical elements. The law which governs the motions of multitudes of men and women in a busy thoroughfare, I have applied to the atoms of gas in a vacuum tube. At this genetic stage the new born particles vibrating in all directions and with all velocities, the faster moving ones would still overtake the laggards, the slower would obstruct the quicker, and we should have groups formed in different parts of space. The constituents of each group whose form of energy governing atomic weight was not in accord with the mean rate of the bulk of the components of that group, would work to the outside and be thrown off to find other groups with which they were more in harmony. In time a condition of stability would be established, and we should have our present series of chemical elements, each with a definite atomic weight—definite on account of its being the average weight of an enormous number of sub-atoms or meta-elements, each very near to the mean. The atomic weight of mercury, for instance is called 200, but the atom of mercury, as we know it, is assumed to be made up of an enormous number of sub-atoms, each of which may vary slightly round the mean number 200 as a centre.

We are sometimes asked why, if the elements have been evolved, we never see one of them transformed, or in process of transformation, into another? The question is as futile as the cavil that in the organic world we never see a horse metamorphosed into a cow. Before copper, *e.g.*, can be transmuted into gold it would have to be carried back to a simpler and more primitive state of matter, and then, so to speak, shunted on to the track which leads to gold.

This atomic scheme postulates a to and fro motion of a form of energy governing the electrical state of the atom. It is found that those elements generated as they approach the central position are electro-positive, and those on the retreat from this position are electro-negative. Moreover the degree of positiveness or negativeness depends on the distance of the element from the central line; hence calling the atom in the mean position electrically neutral, those sub-atoms which are on one side of the mean will be charged with positive electricity, and those on the other side of the mean position will be charged with negative electricity, the whole atom being neutral.

This is not a mere hypothesis, but may take the rank of a theory. It has been experimentally verified as far as possible with so baffling an enigma. Long continued research in the laboratory has shown that in matter which has responded to every test of an element, there are minute shades of difference which have admitted of selection and resolution into meta-elements, having exactly the properties required by theory. The earth yttria, which has been of such value in these electrical researches as a test of negatively excited atoms, is of no less interest in chemistry, having been the first body in which the existence of this sub-group of meta-elements was demonstrated.

CONCLUSION.

I frankly admit I have by no means exhausted the subject which daily and nightly fills my thoughts. I have ardently sought for facts on which to base my theory. I have struggled with problems which must be conquered before we can arrive at exact conclusions—conclusions which, so far as inorganic nature is concerned, can only be reached by the harmonious interfusion—not confusion—of our present twin sciences, electricity and chemistry. Of this interfusion I have just endeavoured to give you a foretaste. In elaborating the higher physics, the study of electrical phenomena must take a large, perhaps the largest, share.

We have invaded regions once unknown, but a formidable amount of hard work remains to be completed. As we proceed we may look to electricity not only to aid, as it already does, our sense of hearing, but to sharpen and develop other powers of perception.

Science has emerged from its childish days. It has shed many delusions and impostures. It has discarded magic, alchemy, and astrology. And certain pseudo-applications of electricity, with which the present Institution is little concerned, in their turn will pass into oblivion.

There is no occasion to be disheartened at the apparent slow pace of elemental discovery. The desponding declare that if Roger Bacon could re-visit "the glimpses of the moon" he would shake his head to think we have got no further, that we are still in a haze as to the evolution of atoms. As for myself I hold the firm conviction that unflagging research will be rewarded by an insight into natural mysteries such as now can scarcely be conceived. Difficulties, said a keen old statesman, are things to be overcome, and to my thinking science should disdain the notion of finality. There is no stopping half way, and we are resistlessly driven to ceaseless inquiry by the spirit "that impels all thinking things, all objects of all thought, and rolls through all things."

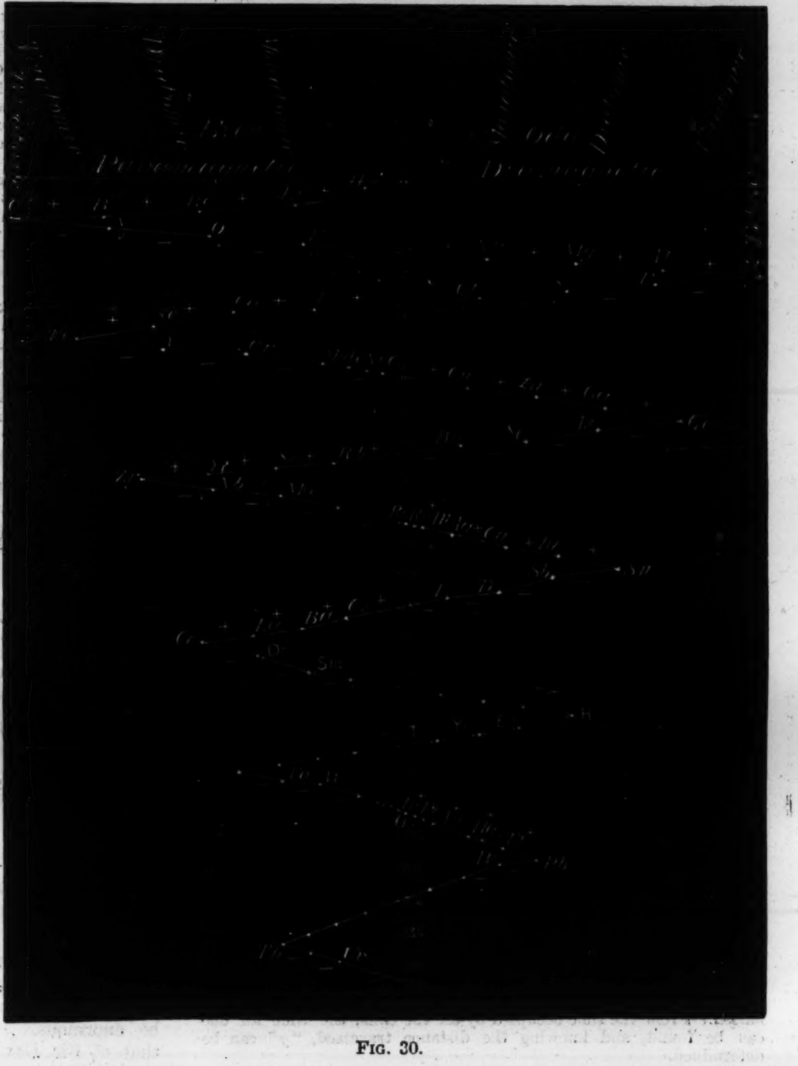

FIG. 30.

Physical Society, January 16th, 1891.

(Prof. W. E. AYRTON, F.R.S., President, in the Chair.)

THE thanks of the meeting were unanimously accorded to the Maxwell Memorial Committee for presenting to the Society a copy of Maxwell's "Scientific Papers."

Prof. G. M. MINCHIN, M.A., read a paper on "Photo-Electricity."* His experiments on the subject were commenced in 1877, in attempting to produce a photographic image of a distant object. The result sought for has not hitherto been obtained, but the experiments have led to the discovery of many interesting phenomena. Some of these were shown to the meeting.

Electric currents are produced by the action of light on silver plates coated with collodion or gelatine emulsions of bromide, chloride, iodide, and other silver salts, or with eosine, fluorescine, and other aniline dyes, when the plates are immersed in a suitable liquid, and one plate illuminated whilst the other is screened. The directions of the currents depend on the materials employed, and the blue end of the spectrum is most effective. Currents have a photographic effect on the plates, and this action is strictly confined to the parts through which the current has passed.

Comparatively strong currents were obtained from plates coated with eosine and gelatine. A curious reversal was observed with some cells, the exposed plate first being positive to the screened one, and almost immediately afterwards became negative. On shutting off the light a transient increase of current resulted, and afterwards disappeared gradually. M. Becquerel, who has studied the action of silver plates coated with bromide, &c., concludes that the nature of the exposed plate (whether positive or negative) depends on the thickness of the surface layer. The electromotive force of such cells rarely exceeds $\frac{1}{20}$th of a volt.

Uncleaned tinfoil plates in common tap water give a current when one is exposed to light and the other screened. Cleaning the plates destroys the effect. In nearly every case the exposed plate was first positive, and, after a time, became negative, and by exposing various parts of a plate (some portions of which had been previously exposed) the currents could be varied in direction at will. These peculiarities may explain the known divergence of tin from Volta's law. The phenomena have also been studied by aid of the electrometer. Tinfoil obtained from tobacco packages was found to be very sensitive to light. One side of such foil is dull and the other bright. By pasting slips of it on opposite sides of a glass plate so that dissimilar sides were outermost, and immersing them in alcohol, a cell giving an E.M.F. of $\frac{1}{18}$th volt, when the dull side was exposed to light, was obtained. The addition of any salt to the liquid, with a view to diminishing the resistance, invariably reduced the E.M.F. Experiment showed that the alcohols were by far the best liquids to use with tin plates. A process for producing very sensitive tin plates was described, which apparently results in the formation of white oxide of tin on the surface of the foil. With one such plate and another insensitive plate, the best results have been obtained by immersing them in methyl alcohol prepared from oil of winter green. From experiments on the variation of E.M.F. with the intensity of light, it was found that the square of the E.M.F. is proportional to the intensity.

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* See special article on page 124.

Some tin cells behave in a very peculiar manner, for it often happens that a good cell will exhibit no E.M.F. after being kept a few days. A slight impulse or tap given to the cell or its support restores the sensitiveness, another impulse makes the cell insensitive, and these effects can be repeated indefinitely. Such cells the author calls "impulsion cells," and some were exhibited at the meeting. The sensitised plate of one of these cells had different properties at its two ends, for impulses had no effect on the nature of the lower end, but changed the upper end from positive to negative and *vice versa.* Electro-magnetic impulses, such as produced by sparks, are capable of altering cells from the insensitive to the sensitive state, but fail to produce the reverse effects; a Hertz oscillator restored the sensitive state in a cell placed at a distance of 81 feet away. The "impulsion effects" can be got rid of by renewing the alcohol on several successive days.

During last year the author made some selenium cells by spreading the melted substance on metal plates and immersing them in liquids together with an uncoated plate. Of the various metals and liquids tried, aluminium and acetone gave the best effects. The process of forming these "seleno-aluminium cells" was described. One of their peculiarities is that they are nearly equally sensitive to rays of all colours; and when exposed to strong light may give an E.M.F. of $\frac{1}{2}$ to $\frac{2}{3}$ of a volt; the sensitised plate being negative. An arrangement of 50 cells in series, with an electrometer, was exhibited, whereby the E.M.F. generated by light falling on the cells could be caused to ring a bell, light or extinguish electric lamps, &c.

In conclusion, the author pointed out the possible applications of photo-electricity to photometry, tele-photography, and the utilisation of solar energy.

At the request of the President, Prof. Minchin promised to show the experiments on February 13th, on which date the discussion on the paper is to take place.

Prof. F. R. **BARRELL**, B.A., exhibited and described a lecture-room apparatus for determining the acceleration due to gravity. A number of iron balls are allowed to fall through a certain height in such a way that one starts off when its predecessor arrives at its destination. From the time occupied by all the balls, the time for one can be found, and knowing the distance traversed, "*g*" can be determined.

The apparatus consists of two electro-magnets joined in series, with a battery and key, together with a ball-feeding device. One of the magnets is vertically over the key, and serves to catch the balls as they emerge from the feeding tube, whilst the other magnet actuates a kind of slide for supplying successive balls.

When one ball falls on the key it breaks circuit, and thus causes the first mentioned magnet to let go its ball. The key then springs up again, thus making circuit; the feeding magnet then supplies another ball, which is caught by the holding magnet until the falling ball reaches the key, and the operations are repeated. Fairly accurate results can be obtained by the apparatus.

Sir John Conroy's paper "On the Change in the Absorption Spectrum of Cobalt Glass by Heat" was postponed.

THE SOUTH KENSINGTON AND PADDINGTON SUBWAY RAILWAY.

PROF. AYRTON has addressed the following letter to the editor of the *Times*:—

"Your readers will remember that a leading article in your columns this year contained the following cogent remark:—'The proposal which has lately been mooted to carry an underground railway into the immediate neighbourhood of the laboratories of South Kensington, where the most delicate investigations in modern physics are constantly being carried on, seems little short of grotesque.' They will therefore be interested in hearing that during the past few weeks Professor Rücker, F.R.S., and myself have been taking measures to ascertain the magnitude of the disturbance that will be caused by the subway railway if it be constructed along the proposed route.

"A description of the details of our experiments would be out of place here, but it may be mentioned that we did not employ any very delicate instruments, such as are necessary for physical research, but only the ordinary rough apparatus that is in daily use by students in a modern physical laboratory. Even such rough apparatus is seriously affected by mechanical vibration, and we have been led to the conclusion that the earth waves produced by the passage of large weights at high speeds affect measuring apparatus far more seriously than the noisy street traffic that rattles the windows of a house.

"It is impossible, therefore, to view without alarm the proposition to construct a subway for heavy tramcars within a few yards of the two important physical laboratories belonging to the Royal College of Science and the City Guilds Central Institution, both of which are used by considerable numbers of students; and our alarm is turned into dismay when we learn that the Bill which Parliament is to be asked to sanction proposes to grant powers to the new company to propel their trains electrically. For every elementary student knows that he must never walk about near even rough galvanometers, electrometers, and other apparatus used in connection with the study of those all-important practical subjects, electricity and magnetism, if either his keys or his knife or his watch be in his pocket. Even a tyro in the subject will not, then, be supprised at our observations showing that powerful electromotors on electrically propelled tramcars constantly passing within a few yards of a physical laboratory would make even rough electrical measurements impossible.

"Now that the nation is devoting so much attention to the spread of technical education, now that Parliament has sanctioned the spending throughout Great Britain of considerable sums for technical instruction, is it possible that the people will allow the Central Institution of the City Guilds Institute, a building that has cost £100,000 to build and equip, and which is the centre of English technical education, to be practically ruined as regards one whole branch of instruction which is participated in by practically every single student of that college?

"If the Central Institution were a private commercial enterprise which would be seriously interfered with by the subway railway, it would certainly have a right to equitable compensation. Surely the fact that this college was founded and is being supported for the public good by the liberality of the city companies does not make its claims any the less. Have the promoters of the proposed scheme ever contemplated the amount of compensation that would be demanded if the question of compensation were entertained? To build a new set of laboratories for applied physics elsewhere would be a very costly undertaking; and, further, such a solution of the difficulty would not meet the requirements of the case, for the time consumed in the students going backwards and forwards between a physical department at a distance and the laboratories, workshops, and drawing offices of the other departments of the college in Exhibition Road would destroy the organised scheme of instruction which is so important a feature of the Central Institution."

REVIEWS.

Electric Installations and the Management of Accumulators. By Sir **DAVID SALOMONS**, Bart. London: Whittaker and Co.

If proof were required testifying to the popularity of electrical science in general, we have only to go to the publishers of electrical literature; the aggregate sale of such books must be enormous. Among the popular "specialist" books is that of Sir David Salomons which has already reached its sixth edition. It has again been revised and somewhat enlarged, the new matter, intended for the "general reader" being embodied in the "introduction." The opening chapter is supposed to give the reader a superficial idea, expressed in "simple ways," of electric lighting. The definitions, however, are not quite so simple as the author intends them to be; for instance: "Dynamos are of two kinds; one made to produce a continuous current, and the other an alternating current. A continuous current may be compared to a liquid wherein waves are continually progressing in one direction. The direction towards which these waves are moving is termed the positive direction, and from whence they come, the negative. Positive electricity and negative electricity have a variety of phenomena peculiar to each. The alternating current may be regarded as a fluid in which a wave proceeds first in one direction and then in the other, see-saw fashion; and in practice these changes of direction take place as frequently as from 50 to 200 times per second. Instruments employed for continuous currents contain iron and permanent magnets, but for the alternating the latter must be completely absent, and any iron employed in their construction must be very soft and much sub-divided, or it will become extremely hot." These sentences occur on one page, and there are about 17 pages of similar expressions in the "simple way," which Sir David has made peculiarly his own. The main body of the book is scarcely altered from the fifth edition, but the supplementary chapter contains much new information relating to recent improvements in accumulators, gas engines, dynamos, motors, switches, instruments, conductors, joints and other descriptive matter not contained in former issues. In an "Addendum" the author replies to a series of practical questions which have been put to him very recently. Sir David Salomons, we admit, thoroughly understands the subjects upon which he treats, but he has a mode of imparting

ing his knowledge to others which is not so lucid as could be wished. The book is beautifully printed and illustrated, and notwithstanding its literary defects, contains a vast amount of really useful information.

Electric Transmission of Energy and its Transformation, Sub-division, and Distribution. By GISBERT KAPP. London: Whittaker & Co.

Scarcely ten months have elapsed since we reviewed, at considerable length, the second edition of this useful book, and now we are in possession of the third. The only serious fault we found in March last was the omission of alternating current motors from a work especially devoted to the electric transmission of power. Considering that the author is practically engaged in and fully conversant with alternating current transmission, we feel inclined to charge him with wilful neglect as long as this void is not filled. The additions in the volume before us are certainly slight ones; they refer in the first instance to the author's own suggestion and definition of the expressions "static characteristic," "dynamic characteristic," and "motor characteristic." The first of these expressions refers to the static balance between the armature and opposing electromotive force; the curve obtainable will represent this condition of working. If we next imagine the opposing electromotive force reduced, so that it will no longer balance the electromotive force of the armature, but be overpowered by the latter, with the result that a current is produced, we obtain the conditions of a dynamo; mechanical energy is absorbed and electrical energy given out. The electrical condition of this working plotted in a curve is called the "dynamic characteristic." If, thirdly, we increase the opposing electromotive force until it overpowers the armature electromotive force, a current will be forced through the armature doing work in overcoming its electromotive force, the machine will be working as a motor, and the characteristic curve thus obtained Mr. Kapp designates the "motor characteristic."

"The dynamic characteristic must always be lower than the static characteristic, and the same holds good generally for the motor characteristic, but there are cases when the motor curve lies above the static curve;" these the author explains in his own happy style.

The only additions of any importance is a reference, with explanatory diagrams, to a novel transmission plant which the author has seen tested in the works of the Allgemeine Elektricitaets Gesellschaft at Berlin. It is a self-regulating device which allows of extreme variations of load giving constant motor speed, the only condition to be observed is, that the generator is driven at constant speed. It follows a theory, explained in the book, according to which a certain relation between the characteristics of the two machines ensures constant speed of the motor at all loads. The plant described consists of a 20 kilowatts generator of the Edison type, working with a normal current of about 25 ampères, a motor of the same type and leads connecting the two, having a resistance of 1·25 ohms. The generator runs at 1000 and the motor of 800 revolutions per minute. The general dimensions of motor and generator differ comparatively little. The magnet cores of the motor are slightly smaller in diameter than those of the generator, and the yoke is somewhat lighter. The armature cores are alike in both machines, viz.: $11\frac{5}{8}$ inches in diameter, and $12\frac{5}{8}$ inches long, but whereas in the generator only five per cent. of the space is taken up by paper insulation, the space thus taken up in the motor amounts to 25 per cent., in other words, we suppose there is 20 per cent. less iron in the motor armature. The winding of both armatures is the same, and consists of 780 turns of ·657 ohms resistance. Each field magnet core is wound with 553 turns of wire, but the resistance of the coils in the generator is 1·53 ohms, that of the motor 1·44 ohms, the reduction in the resistance being due to the smaller diameter of the motor magnet cores. In the generator is also a shunt resistance of 20 ohms, arranged across the terminals of the field coils. This shunt is a coil of wire doubled back on itself so as to have no self-induction. By the addition of such a shunt any slight error in the design of the machines can be rectified, and a perfect agreement between their characteristics obtained; it is also said to increase the rapidity with which one machine corresponds to the other. If the load on the motor be suddenly diminished, the current will be as suddenly checked. By the adoption of the shunt, which acts as a kind of electro-magnetic damper or dash-pot, the kick from the magnet is principally taken up by the shunt wire, and the machines are thereby able to attain quickly their steady working condition. With the above mentioned exceptions the present book is practically a reprint of last year's edition.

NOTES.

The Electric Light at Falmouth.—A high-class hotel with winter garden and swimming baths, is about to be commenced at Trefuses, Falmouth. All the capital has been found by a London syndicate, who have determined, in order to make the building as attractive as possible, that it shall be fitted with all modern appliances, and illuminated by the electric light.

Electric Lighting at Brighton.—Some sharp differences of opinion manifested themselves at the meeting of the Brighton Town Council last week, when the General Purposes Committee submitted draft objections to the application of the Brighton and Hove Electric Light Company, Limited, for a provisional order to authorise them to supply electricity within the borough. It was urged that the Council were bound to oppose the application, to protect their own rights, while another member stigmatised the action of the Committee as a "dog in the manger" policy. To this it was replied that it was only the hard work of the Committee and the sound good sense of the Council that had prevented the growth of a monopoly. If there were to be a monopoly a hope was expressed that it would be in the hands of the Council, like the water. A member remarked that he was for competition in a reasonable way, but it would be unreasonable to allow a company to come in, and then afterwards have to buy them out. Another member expressed the opinion that they were making an investment which would turn out, if they only supported it as they should do, one of the grandest investments ever made in any town in the country. The report and the draft objections were then adopted.

Electric Lighting at Exeter.—The Town Council has adopted the report of the Parliamentary Committee, advising that body to put in a formal objection to the granting of a provisional order to the Exeter Electric Light Company. In addition the Town Clerk has been instructed to take such action as he thought fit in order to carry into effect the resolution of the Council, with regard to obtaining a provisional order for electric lighting.

Proposed Electric Light at Dorking.—The Electrical Committee has visited several towns where the electric light is installed, viewing the works and collecting information. They will visit several more and report.

Lightning in Belgium.—From the official returns of the thunder storms observed, and the damages caused by lightning in Belgium, during the years 1884—1888, we extract the following:—

	1884.	1885.	1886.	1887.	1888.
Persons killed ...	16	13	5	7	15
Houses set on fire ...	28	29	54	17	19

The Woodward Storage Battery.—We learn that Dr. Woodward, the founder of the Woodward Electrical Company of Detroit, U.S.A., has arrived in this country with a view to establish electrical works in England for the manufacture of the Woodward battery, which is now made for domestic and central station work in various sizes from 100 ampére hours capacity up to 2,000 ampére hours. One great advantage claimed by Dr. Woodward for his new type cylindrical battery is that it will stand a much higher rate of charge and discharge than the grid form of plate, and buckling of the cylinders is impossible.

Large Private Electric Light Installation.—The Marquis of Londonderry has decided to electrically light Wynyard, his palatial residence in the county of Durham. No less than 750 incandescent lamps will be employed, and the plant will comprise steam engines and dynamos of some 100 H.P. in the aggregate. The contract for the installation has been placed with Messrs. Drake and Gorham, who will carry out the work under the superintendence of Mr. A. A. Campbell Swinton as consulting engineer.

The Microphone in Seismic Observations.—We reproduce the following note from *Nature* of January 1st:—The utility of the microphone in observation of earth tremors and noises was soon recognised, and, in Italy especially, attention has been given to adapting the instrument for this use. We learn from the *Revista Scientifico-Industriale* that Signor Baratta, finding some defects in a method of mechanical registration of the motions of a seismo-microphone which he had devised, has substituted a photographic system with advantage. The device is briefly this: The telephone wire is connected with a subterranean microphone. Before the telephone diaphragm (vertical), and connected with its centre by a fine aluminium wire, is a short slip of the same metal, fixed below, and having a curved piece at the top, which rests against a small mirror, movable about a horizontal axis. This mirror reflects the light from a lamp and lens to photographic paper on a rotated drum. The light is momentarily shut off every quarter of an hour by a shutter arrangement, worked electromagnetically by the clockwork which moves the drum.

Boult's Comprehensive Wire Table.—However useful the tables hitherto published relating to the properties of copper conductors may have been found by electrical engineers, there has been always the drawback that they have only been adapted for use in the country whose standard has been used. Mr. Wilfrid S. Boult has compiled a table in which will be found particulars of some 452 copper wires, varying in diameter from 2·26 inches to ·001 inch. It includes data pertaining not only to the two English gauges, but also to the American Brown and Sharpe and the metric gauges. All are arranged in consecutive order, and the particulars of the different gauges are worked out on the same basis. The resistances are calculated from Matthiessien's standard at a conductivity of 98 per cent. The figures published by Mr. A. E. Kennelly in regard to the heating of insulated and bare conductors have, by permission, been incorporated in the table in their proper place. These figures will prove extremely useful, and are practically, for rise of temperature with normal current, at one with the limit set forth by the Institution of Electrical Engineers. As one page is devoted to only nine wires, and the figures are arranged in vertical columns with a description at each end of the page, it will be seen that any particulars can be found with a minimum of labour and with the remotest chance of reading incorrectly. We can cordially recommend this book as an indispensable addition to every practical electrician's library.

The Troubles of the Westinghouse Company.—A Pittsburg telegram states that the probable outcome of the troubles of the Westinghouse Electric Manufacturing Company is that under the guise of a consolidation company, it will be absorbed by its Great Eastern rival, the Thomson-Houston Company. One thing is considered certain—either receivership or consolidation is inevitable for the Westinghouse Company.

Legal.—Ordering Tickets by Telephone.—On Thursday last week, in the Westminster County Court, the case of Mitchell *v.* Isaacs came before Judge Bayley. The plaintiff sought to recover 13s. 6d. for a stall ticket for Drury Lane Theatre. He alleged that in December, 1889, a message was sent through the telephone to send a stall ticket to No. 2, Tavistock Square, for Mr. A. Isaacs. The ticket was sent and handed to a servant. Defendant denied that he had ordered the ticket, and said it must have been a joke of some one's. He had never had the ticket. His Honour gave judgment for the defendant with costs.

The London-Paris Telephone.—The cold weather has delayed the progress of this enterprise, and the service will consequently not be begun until the 1st of March. The 15th February is the date fixed for the submersion of the cable, and the official trials will last until the end of the month. The tariff has been fixed at 10 fr. for three minutes' use of the telephone. It is said that the new telephone will be formally inaugurated by Queen Victoria and M. Carnot, who will exchange greetings over its wires.

Sparkless Electro-Magnets.—*Industries* says:—"Among the numerous points of interest in Prof. S. P. Thompson's Cantor Lectures on 'Electro-Magnets," is a discussion of sparkless electro-magnets. Among these he mentions the double-wound, or differential, electro-magnet. This, we believe, was invented by Dr. Thompson himself, but the theory given seems inaccurate. According to the learned lecturer, there is no spark on making the circuit, because the magnet is magnetised already, and none on breaking, because there is then no magnetism. This is inaccurate, because the spark does not depend on the magnetism, but on its rate of change. If the current in the second wire were kept constant, there would be a spark on breaking the first. As it is the second wire acts as a secondary, and the current in it is reduced by the increasing magnetisation. If a second single-wound magnet were put in this second circuit, so that any variation of the current would be opposed by its self-induction, a spark would be produced on breaking the first circuit. A simple and effective way of making a sparkless electro-magnet is to put some voltameters, made of lead plates in dilute sulphuric acid, in shunt to the break. These act as condensers of enormous capacity, and run down completely on short circuit. Prof. Thompson is, apparently, writing an exhaustive historical and practical encyclopædia of electrical engineering. The articles on dynamos, transformers, arc lamps, influence machines, telephones, mercury pumps, storage batteries, and electro-magnets are now complete. We wait for those on primary batteries, permanent magnets, incandescent lamps, central stations, steam engines, chimney construction, boilers, and a few minor subjects."

Underground Conductors.—A recent diplomatic report says: "The project of uniting Munich and Berlin by means of an underground cable was recently introduced in the Bavarian Legislature. All that is necessary is the laying of a cable to the Bavarian frontier town of Hof, where it would connect with the Saxon cable to Dresden, which is a continuation of the underground telegraph line from Berlin to Dresden. In 1876 a test line was laid from Berlin to Halle, a distance of 169 kilometres. At the close of 1883, 30,000,000 marks had been expended in the development of an extensive underground telegraphic network. At the close of 1888 the Imperial Post and Telegraph Department had in operation 74,740 kilometres of overhead lines with 244,892 kilometres of wires, and 6,350 kilometres of underground lines with 38,019 kilometres of wires."

Evarou

The French West India Cables.—The ss. *Westmeath* was signalled off Portland on January 16th, on her return from what appears, by all accounts, to have been a remarkably successful expedition. We learn that in addition to the connecting of Martinique with Paramaribo, and Mole St. Nicolas with Port au Prince, about half of the Cayenne-Paramaribo, and a considerable portion of the Puerto Plata sections, have been laid, the work seems to have been executed most expeditiously, considering that owing to shallow water off Paramaribo a considerable length of cable had to be laid out of lighters and schooners. We are glad to hear that the cables, both electrically and mechanically, are in perfect condition, and that the health of all on board has been excellent.

Electric Gala Illuminations.—On the occasion of the forthcoming celebration of the German Emperor's birthday, there will be 25,000 glow lamps installed for outdoor illuminations, and they will be arranged in a novel and tasteful manner. They are to be supplied by the Berliner Elektricitäts Werke, the office buildings of which company on the Schiffbauerdam alone will have a display of 6,000 lamps on its front.

Elmore's Patent Copper Depositing Company.—The directors have issued invitations to the leading journals to inspect their works in operation near Leeds on Tuesday the 27th inst. This will be the first public inspection of the Elmore system for the manufacture of copper articles by electro-deposition, and should be of great interest.

The Electro-Harmonic Society.—The next Smoking Concert of this Society takes place on Friday evening, the 30th inst. The vocal element is strong, the instrumental scarcely less so, and members may therefore anticipate a very enjoyable réunion.

The Keys' Electric Company.—An exhibition, no less novel than practical, is that of the Keys' Electric Company, Limited, of 122 and 124, Charing Cross Road, W.C. It comprises, among other useful applications, that of electric motors to domestic purposes, and on the ground floor of the company's extensive premises may be seen, in daily operation, a butter churn, a washing machine, a wringer, a knife cleaner, a boot-cleaning machine, a sewing machine, and a lathe for metal workers, all worked electrically from one common source of supply, which is derived from a gas engine, dynamo and accumulators in the building. On the first floor, extending over the whole length and breadth of the house, have been installed a number of electroliers, many of which are of exceptional beauty, containing upwards of 350 16 candle-power lamps, which can be lit simultaneously, illuminating the hall with a splendour seldom witnessed. The Keys' Company is an offshoot of the powerful and well-known Allgemeine Electricitäts Gesellschaft, of Berlin (formerly German Edison Company), and with such substantial parentage it ought to make its way on this side of the Channel. The various productions of this eminently successful Continental firm are well worthy of careful study of all interested in electric lighting accessories. We hope to describe some of the numerous novelties at an early opportunity.

Electrical Exhibition at St. Pancras.—It is proposed to hold an exhibition of electrical appliances in the Vestry Hall, St. Pancras. The Stanhope Street station will be completed by June next, and many inhabitants of the district it will serve are already asking for information about terms, mode of supply, &c., and with respect to the best and most economical mode of fitting up their houses and shops. The proposed exhibition will supply this information. It is proposed that the exhibition be held next month. It will be open for a week. The expenses will be defrayed by letting space to exhibitors, and by a small charge for admission.

Proposed Electric Railway for New York.—A news agency states that a company has been formed at New York, with $3,000,000 of capital, to carry out a scheme for connecting New York City, Brooklyn, Jersey City, and Haarlem by a tunnel and a service of electric trains. Mr. Austin Corbin and other very wealthy financiers are promoting the scheme. It is intended to be a practical solution of the rapid transit problem, and will extend both sides of New York City by connecting Brooklyn and Jersey City near Castle Garden.

Electrical Trades' Section—The London Chamber of Commerce (Incorporated).—A meeting of the Electrical and Allied Trades' Section Committee will be held at Botolph House, on Monday next, the 26th inst., at 4 p.m., when the following agenda will be submitted :—1. Board of Trade Provisional Orders in regard to Telephones—suggested modifications in. 2. Board of Trade Rules and Regulations *re* Overhead Wires—report of sub-committee. 3. Board of Trade Forms of Accounts—report of sub-committee on. 4. Board of Trade Electrical Standards Committee—correspondence in connection with. 5. Proposed Exhibition in London of Electrical Appliances—letter from Mr. Seymour Wade. 6. St. Pancras Electrical Exhibition—letter from Messrs. W. T. Goolden & Company. 7. Automatic Electric Railway Signalling—letter from Mr. Martin Perls, proposing address on "Is railway travelling safe as managed at present ?" 8. Other matters.

The Electro-deposition of Copper.—The following communication, which came to hand as we were going to press, will prove of considerable interest to those who are watching the development of an electro-deposition process, and especially so to those who still pin their faith on the utterances of the REVIEW. "The letter of Mr. Percy R. Allen, explaining the difference between the Wilde and Elmore processes for the electro-deposition of copper, is interesting, in that it confirms all the statements made in my letter of 28th November; but neither Mr. Allen or others of your correspondents have given any information as to the cost of articles of electro-deposited copper, for industrial purposes, as compared with the cost of similar articles of mechanically wrought copper. I have already stated in substance, what Mr. Allen reiterates, that the principal object of Mr. Wilde's invention was the covering of articles with copper, and not the production of copper articles, for the good reason that such electro-copper articles cannot be produced, except at a cost largely in excess of similar articles formed of wrought copper, and without any commensurate advantage in point of quality. The substitution of electro-coppered iron rollers and cylinders for solid copper effects an economy of more than 95 per cent. of the copper formerly employed, so that the additional cost of the electro-copper deposited on the iron bears a very small proportion to the economy effected. Some idea may be formed of the importance of this advance in electro-metallurgy, when it is stated that the stock of rollers held by many calico-printing firms is valued from £20,000 to £50,000 for the copper alone, without the cost of the engraving. Operating on a large scale, it has been found that articles of electro-deposited copper cannot be produced in cylindrical and circular forms for industrial purposes at less than double the cost of similar articles of mechanically-wrought copper. It is extremely fallacious to assume that the cost of electrically-refined copper can be taken as a basis of the cost of producing cylindrical and circular articles in electro-copper, as the electrolytic conditions and the disposition of the electrodes are necessarily different in the two cases. Messrs. Elkington and Company, the inventors of the electro-refining process, attempted some years ago to utilise their process in the production of tubes and other articles, but soon found it to be impracticable. To those who are practically engaged in the electro-deposition of copper, there is something ludicrous in the notion of submitting the miscellaneous objects specified by Mr. Allen to the mechanical operation of burnishing during the process of deposition. The burnishing process might be useful for the production of a specimen for an international exhibition, or to swear by in a court of law on the sufficiency of the patent specification, but it is not likely to enter into the regular practice of electro-metallurgy. The statements now made as to the greater cost of electro-deposited copper will no doubt be challenged, from the fact that electro-copper tubes are now being offered to users at the same price as ordinary solid drawn tubes. Those who have followed closely the progress of the electric lighting industry, will remember with what confidence it was stated that the new illuminant was cheaper than gaslight, and how large contracts were entered into for lengthened periods for electric lighting at the same price as gas, and with what disastrous results to the companies engaged therein. History would appear to be in a fair way of repeating itself in the metallurgical applications of electricity. It is difficult to distinguish gas from incandescent electric light, and equally difficult to distinguish electro deposited from mechanically wrought copper. There is, therefore, nothing to hinder large shipments of wrought copper being palmed off upon confiding Britons, for electro copper, just as some foreign wines, innocent of the juice of the grape, have become regular articles of commerce. The connection of M Sécretan with the electro-depositing industry, reported in your issue of the 16th inst., and mention of the Société des Metaux is ominous, and suggests a new feature of commercial enterprise in copper which it may become necessary to deal with hereafter.—JOHN HILL."

The Smoke Nuisance at Woking.—The Woking Electric Supply Company is now burning Welsh steam coal, so as to abolish the nuisance caused by the smoke from their chimneys.

Another Post Office Scandal.—A well-known electrical firm in the country sent a brace of pheasants to one of the engineers of a London company by parcels post. Not being delivered, a claim of 10s. was made for them, and in response to this the following reply was received :—

G.P.O., *January 20th*, 1891.

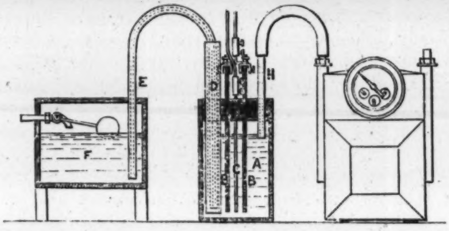
Gentlemen,—Referring to your application of the 8th inst., I request you will be good enough to inform me whether the pheasants sent to Mr. —— were two male birds, or male and female.

I am, Gentlemen, your obedient servant,

S. H. BLACKWOOD, *Secretary*.

If we had not seen the official reply, we should have had serious doubts as to whether the writer was of the masculine gender or simply an old lady, but the signature put our mind at ease on this score ; but in strictly proper circles will it not be deemed simply scandalous that the *employés* of the Post Office have nothing better to do than to examine and decide upon the sexes of the birds entrusted to their care ? But perhaps it is only a method of identification, after all.

Elieson's Electricity Meter.—From the illustration the construction and principle will be readily comprehended. A is a closed vessel containing acidulated water to be decomposed. B and C are electrodes placed in the vessel, and connected with the main conductors carrying the current to be measured. D is a tube open at both ends, and inserted through the cover of the vessel, A. The lower end of this tube extends near to the bottom of the vessel, A, while the upper end of the tube reaches, as shown, some distance above the top of the vessel. E is a siphon which serves to maintain the level of the liquid in the closed vessel at its normal height. F is a supply tank kept filled by the action of a trap. H is a tube communicating with any suitable gas meter. As the current flows through the liquid in the vessel, A, a portion of the liquid, depending upon the quantity of the current, will be decomposed. The gas liberated collects in the upper part of the vessel until the bottom of the tube, H, becomes exposed. The collected gas now escapes into the meter under the pressure of the column of liquid in the tube, D, and the liquid in A resuming its normal level, again closes tube H. This action is repeated again and again, the quantity of gas generated indicating the quantity of current passed through vessel A.



The Royal Society.—Mr. H. Wilde, F.R.S., was to read last night a paper "On the Unsymmetrical Distribution of Terrestrial Magnetism.

Important Reductions in International Telegraph Rates.—M. Jules Roche has just signed a measure approving the telegraph rates drawn agreed to at the Paris International Telegraphic Congress on June 21st last, and private arrangements come to with Germany, Belgium, Luxembourg, Holland, Russia and Switzerland. These arrangements offer great advantages to the public, the telegraph rates being reduced as follows by this measure :—For Russia, from 50 c. to 40 c. ; for Germany, from 20 c. to 15 c. ; for Sweden, from 35 c. to 30 c. ; for Belgium and Switzerland, from 15 c. to 12½ c. ; for Holland, from 20 c. to 16½ c. ; for Luxembourg, from 12½ c. to 10 c. ; for Austria-Hungary, from 25 c. to 20 c. ; for Senegal, from 2 fr. 50 c. to 1 fr. 50 c. Compound words will count as one word, and in addition telegrams will be communicated by telephone. Urgent telegrams will have a right of priority. Repayment will be obligatory for words not employed, and, finally, the international vocabulary will be composed of 200,000 words.

What is Wanted in Darkest Africa.—According to the familiar announcement of Messrs. Woodhouse and Rawson it is the electric light, but Mrs. Sheldon, the American lady who is about to visit Central Africa to study the domestic life of the savage tribes, appears to think differently. This lady, whose only companions are to be black women, Arabs, and a military escort, takes with her a phonograph, with which to obtain a permanent record of African voices.

Electric Lighting Contracts.—A well-known firm of electrical engineers write to us on the subject of the unfairness of inviting English firms to tender for foreign work when in no case is the contract ever given to one of them. This matter, it will be remembered, formed the theme of an article in our pages a few weeks since, and our correspondents remark :—"Does not this also apply to Ireland ? The contract for Dublin, and also for Mullingar Asylum, has been, or is going to be, placed with the Electrical Engineering Company of Ireland, and considering that there are many firms, at any rate for Dublin, lower in price than this company, it seems as if it is quite useless for an English firm to send in a tender for Irish work." Well ! perhaps after all, this is only a *quid pro quo* for the feeling which once held sway in this country when advertisements used to end "No Irish need apply."

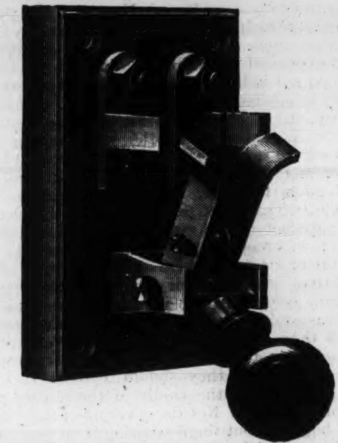
G. Bailey Toms and Co.—This firm has sent us a copy of its new illustrated list of portable railway, locomotives, rolling stock, cast iron pipes, columns, &c. Particulars are given in it of over two thousand sizes of iron and steel joists, channels, angles, tees, fancy sections, &c.

The School of Electrical Engineering and Submarine Telegraphy.—We are informed that Mr. Lèon Drugman, M.Inst.E.E., manager of this school, has obtained the consent of Sir Samuel Canning, M.Inst.C.E., M.Inst.E.E. ; Messrs. P. Herbert Carpenter, D.Sc., F.R.S. ; Gisbert Kapp, M.Inst.C.E., M.Inst.E.E. ; and Prof. Alex. B. W. Kennedy, F.R.S., M.Inst.C.E., M.Inst.E.E., Vice-President Inst.M.E., to form a permanent "Consulting Committee," who will have the control of the teaching of the school. After having had to record a month ago the untimely death of Mr. W. Lant Carpenter, we can now confidently congratulate the school upon having secured the valuable co-operation of professional men of such high standing.

Proposed New Electric Tram-Line.—On Monday, the 19th inst., the St. Luke's Vestry, accompanied by Mr. M. C. Meaby, the surveyor to the vestry, and Mr. J. W. Ransom, the engineer of the North Metropolitan Tramways Company, visited the General Electric Power and Traction Company's electric cars and installation on the Barking Road section of the North Metropolitan Tramways Company's system. Having made a minute inspection of the many points of interest in the working of the cars, the vestry expressed themselves as greatly pleased at all they had seen. The tramway company having signified their intention to run electric cars from Stamford Hill to Moorgate Street, and as this vestry controls that portion of the route which includes Moorgate Street, their inspection was on that account most exhaustive.

Fatal Accident at Southend.—A shocking accident occurred at Southend on Sunday night, by which Mrs. Ellen Titterton, a resident of Southend, met her death under very distressing circumstances. About half-past seven in the evening the woman was attempting to get on to the pier by way of the balcony which surrounds the toll-house, when she fell through a hole in the floor which is used by Messrs. Crompton for connection with the funnel in supply of the electric light. The unfortunate woman fell on the pavement below, a distance of some 20 feet, and was terribly injured, her spine being dislocated, and her head very badly fractured. She was at once conveyed on the police ambulance to the Southend Victoria Hospital, but although everything possible was done for her, she died during the early hours of the morning.

Electrical Accessories Company.—This company has just issued some illustrated sheets, giving the latest forms of their specialities in fittings, shades, globe carriers, switches, cut outs, ceiling roses, and other requirements. The switch illustrated is an improvement on the well-known "ring contact" switch patented by Messrs. Drake and Gorham some years ago. The advantages of the design are: 1st, the lower cost; 2nd, the smaller space occupied; 3rd, the greater springiness afforded by the long arms as compared with the small split rings. It will be seen that the current is carried by the U-shape strip from one terminal piece to the other; this is a special feature of the design, as it avoids any possibility of heating. The tension at the contacts is regulated by the distance pin between the arms. A flat steel spring is fitted to the base to keep the bar in its extreme "off" position when the circuit is open; the switch may accordingly be fixed horizontally or with the handle at top, if such positions are considered more convenient than that illustrated.



The New Peru and Chili Cables.—Advices have been received that the ss. *Silvertown* completed on January 15th the Chorillos-Iquique section of the Central and South American Company's new cable extension between Chorillos, Iquique, and Valparaiso.

Dynamo Brushes.—A friend writes: "How would it answer to use iron for commutator and brush as well? The friction would be less than with copper, while an even pressure free from jumping might be secured by magnetic attraction."

Motors for Driving Looms.—Herr Lembcke, manager of the Crefeld Weaving School, has experimented with electric motors in that establishment, and he finds that they are much more suitable for driving domestic weaving looms than gas motors.

Wire Samples.—Mr. W. T. Glover, who recently called on us, showed us some excellent specimens of his firm's vulcanised rubber leads, in the form of telephone cables and concentric and other electric light leads.

Electric Lighting Nuisances.—The residents around the Manchester Square station of the Metropolitan Electric Supply Company are complaining of the nuisance caused by the machinery, and, in the course of two or three weeks, we may expect to see this matter figuring in the Law Courts. In these days it is better to be a lawyer than an electrical engineer.

Lighting and Power Installation.—At Neuss, not far from Düsseldorf, an electric light and power installation has been put up in a saw mill belonging to Messrs. Wehrhahn. The dynamo not only lights the mill, but also supplies current to a 20-H.P. motor, which is used for lifting into the building, by means of chains, &c., the trunks of trees brought thither on the Erft canal. The motor performs its work very well, notwithstanding the frequent reversals of motion, and the irregular weight of the loads lifted. The lighting is said to be satisfactory, even when the motor is working with varying loads, and this is attributed to the "extraordinarily good compounding" of the dynamo.

NEW COMPANIES REGISTERED.

North Eastern Telephone Company, Limited.—Capital £4,600 in £1 shares. Objects: To adopt an agreement of 23rd ult. between the Primary Syndicate, Limited, and A. H. Cowie. To carry on the business of a telephone, telegraph and electric light, heat and power supply company. Signatories (with one share each): W. M. Angus, George Angus, T. D. Challoner, E. Fawcus, all of Newcastle-on-Tyne; E. S. Hindmarsh, Gateshead; J. V. Walton, Wilton, Durham; Jas. Monks, Aden Cottage, Durham. The signatories are to appoint the first directors; qualification 100 shares; the company in general meeting will determine remuneration. The directors of the Primary Syndicate are appointed *ex officio* directors of this company. Registered 14th inst. by Waterlow Brothers and Layton, Limited, agents for H. W. Sample, solicitor, Newcastle-on-Tyne.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Tubular Frame Waggon Company, Limited (civil, mechanical, and electrical engineers).—The statutory return of this company, made up to the 20th October, was filed 31st ult. The nominal capital is £200,000, divided into 199,600 ordinary and 400 founders' shares of £1 each. The shares taken up are 109,100 ordinary and 400 founders' shares. Upon 85,000 shares the full amount is considered as paid up, and upon 24,500 the sum of 10s. per share has been called. The calls paid amount to £8,500, and unpaid to £3,750. Offices, 93 and 94, Gracechurch Street, E.C.

Bullers, Limited.—An agreement of 3rd ult. (filed 8th ult.), provides for the purchase by this company of the business of Buller, Jobson and Company, Limited, the new company to pay and discharge the debts, liabilities and obligations of the old company as existing on the 1st August, 1890, or subsequently incurred. The purchase consideration is the payment of £5,000 to H. Proctor Ryland, in consideration of 500 fully paid preference shares held by him in the old company, with interest at 6 per cent. from 1st August; further, the issue to the holders of "A" and "B" shares in the old company of fully paid preference and ordinary shares in this company, to the former, equal to the total amount paid up at par on the "A" shares, and to the latter, equal to the amount of the annual dividends actually paid, or to be paid, on the "B" shares for the three years ending 31st July last, and including the dividend earned as on, and up to, that date. One-half the shares so issued are to be preference shares, and the other half ordinary shares. An agreement of 4th ult. (filed 8th ult.) confirms the above.

Chatham, Rochester, and District Electric Lighting Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 16th inst. The nominal capital is £50,000, in £5 shares. 2,027 shares are taken up, upon 2,000 of which the full amount has been called, and upon the remaining 27 shares £1 per share has been called. The calls paid amount to £10,025, and unpaid to £2.

National Company for the Distribution of Electricity by Secondary Generators.—The annual return of this company, made up to the 31st ult., was filed on the 10th inst. The nominal capital is £500,000, divided into 3,000 preferred and 47,000 ordinary shares of £10 each; 2,669 of the former, and 20,000 of the latter, have been taken up. 1,000 preference and the whole of the ordinary shares are credited as fully paid up. Upon 1,669 preference shares the full amount has been called, the calls paid amounting to £17,690. The sum of £1,000 has been received upon 100 shares forfeited.

British Electric Light Company, Limited.—The annual return of this company, made up to the 14th inst., was filed on the 15th inst. The nominal capital is £100,000, in £10 shares. 8,410 shares are taken up, 914 of which are considered as fully paid. Upon 7,496 shares the full amount has been called and paid.

Automatic Electrical Corporation, Limited.—The annual return of this company, made up to the 6th inst., was filed on the 10th inst. The nominal capital is £75,000, in 3,750 shares of £20 each, the whole of which are taken up and are credited as fully paid.

Planet Electrical Engineering Company, Limited.—The annual return of this company, made up to the 29th ult., was filed on the 10th inst. The nominal capital is £20,000, in £5 shares. 1,277 shares are taken up, 700 being considered as fully paid. Upon the remainder the full amount has been called and paid; the total of the calls paid being £2,885.

Electric Tramcar Syndicate, Limited.—The annual return of this company, made up to the 12th inst., was filed on the same day. The nominal capital is £20,000, in £10 shares. 1,744 shares are taken up, 1,300 of which are considered fully paid. Upon 444 shares the full amount has been called, the total of the calls paid being £4,076 10s., and unpaid £363 10s.

Ecuador Telephone Company, Limited.—The annual return of this company, made up to the 18th inst., was filed on the 15th inst. The nominal capital is £100,000, in £5 shares. 5,000 shares are taken up, and the full amount has been called and paid thereon.

Fareham Electric Light Company, Limited.—An agreement of 15th inst. between this company and the Laing, Wharton and Down Construction Syndicate, Limited, provides for the allotment to the latter of 1,950 fully paid shares of £1 each, in consideration of plant, machinery and apparatus supplied as per agreement of 30th January, 1890.

CITY NOTES.

The National Telephone Company, Limited.

The following notice was issued some days ago:—"In consequence of the expiration of one of the company's master pantents on the 9th December, 1890, the directors are of opinion that the shareholders should be made fully acquainted with their views upon the present position and future prospects of the company. They therefore convene a meeting of shareholders, to be held at noon, on Thursday, the 22nd January, 1891, at the Cannon Street Hotel, Cannon Street, London, E.C."

In response to this notice a large number of shareholders assembled yesterday at the Cannon Street Hotel. The room was inconveniently crowded, many shareholders being unable to obtain admission.

The Chairman (Mr. Frederick Richards Leyland) apologised for the inconvenience shareholders were suffering, but it was impossible to get a larger room in the hotel, the Great Hall being engaged. The meeting was not one of their usual assemblies where they were to place before the shareholders certain resolutions to be passed; it was more in the nature of a conference, which the directors were desirous of having, in order to explain the present position of the company, now that the first of their master patents had expired. The directors thought at first it was their duty to communicate their views to the proprietors by means of a circular, but as this might have resulted in a division of the shareholders, it was better to meet face to face, so that each might have the advantage of interchanging suggestions. Going into the accounts for the past 6 months, made up to the 31st October, the speaker said they showed the company's earnings to be a net profit of £108,170 19s. 11d. This, together with £1,113 9s. 7d. brought forward, made an amount of £119,284 4s. 6d. standing to the profit and loss account to 31st October. Out of that they had paid an interim dividend amounting to £62,973; there remained £56,311 which, with the profits that would be made in the second half-year, the shareholders would dispose of at the next ordinary meeting. They would agree with him that those results were a very satisfactory advance on the profits of the previous year, in which period the revenue amounted to £185,754; dividing that into two, they would see the average half year's profits were about £92,700 as compared now with £108,000. Last year they called up a sum of £260,000 for an issue of 52,000 new ordinary shares, they had recommended that as being a wise plan, and their convictions that the new capital would earn as good a profit as the old turned out to be realised. (After interruptions caused by shareholders on the outside of the door clamouring for admission) the chairman, proceeding, said that the result of revenue enabled them to pay quite as good a dividend on the larger capital as they had previously. This was important in so much as the bigger capital rendered the position of the company still more impregnable. Since the new accounts—to October 31st—had been made, the ratio for the two months ending December showed a larger increase. On the 1st of January, the date on which the first Master patent expired—although the second did not run out until July—they thought it was the wisest plan to make a reduction of rates to subscribers. The result of that of course was that the revenue was immediately reduced, but the reduction would bring in a great number of additional subscribers. In that way they would recoup themselves for their loss, and he ventured to think more quickly than was imagined. Looking at the indications of an increase, he found that during the last 26 weeks of 1890, they obtained 914 new subscribers; in the first three weeks of this year, owing to the reduction, they obtained 651; if that continued it would be a comparatively short time before the whole loss caused would be recouped. As he had said over and over again, the possession of monopoly which they had had for many years had not been altogether an unmixed blessing. Having explained the revenue side of the account, he would turn his attention to the capital expenditure, for the shareholders must remember that they could not link up a fresh town, nor put on an additional subscriber, without incurring expense. It was unavoidable, so long as they continued the policy of developing business and covering the ground, a policy which was shown by the figures to be a good one. Now what had they expended on those first six months of capital expenditure? They had expended on exchanges, trunk lines, &c., the large sum of £96,970, £45,000 of which had been expended in linking up different towns in the provinces. He would not inflict upon the shareholders the reading of the list, but they numbered altogether about 244. These towns were now all linked up, and in communication with one another. This he thought would be the salvation of the company, for a competitor could only give a local service, unless he was prepared to spend enormous amounts of money as they had done, in linking all the different towns in the kingdom together. The greater portion of the work on which that £96,000 had been expended was completed, and was yielding a very satisfactory and growing revenue, and although when they linked two towns together they could not expect next day to find the whole thing full of work, they were so satisfied of the ultimate result, that they were actively pursuing their policy and bringing into communication all the main centres in the provinces and connecting towns wherever there was a fair chance of getting a suitable revenue. This, of course, involved them in a big and increasing expenditure, which could not be met out of revenue. At their last meeting a shareholder had suggested that they should confine their extensions to the amount they put to the credit of the reserve fund. What would such a policy mean? Not the covering of the ground and the development of business, but the restricting it to very narrow limits, and other people would take up the business they had not the courage to venture on. The directors had considered very carefully the question whether the additional capital would be best raised by preference shares or debentures, and they had decided on debentures. This would be the cheapest way, and would avoid many complications which must arise if they issued new preference shares, in consequence of their having two classes of preference shares already. Having decided on debentures, the directors decided to issue from time to time so much as should be necessary for the purposes of the company, but they would take care that the debentures issued should be part of a very large sum, so that any subsequent debentures they might issue would all rank alike; indeed, he would suggest that the directors should consider the advisability of issuing as large an amount of debenture stock as they were authorised to by the articles of association, which limited them to a snm not exceeding one-half of the capital. These debentures when issued would rank as first debentures. The holders of their present £80,000 debentures would have the option of exchanging them either for cash or new debentures. It would be much better for them to be holders of debentures in a large stoek which would certainly be quoted on the Stock Exchange, and greatly dealt in, than to be holders in a small stock for which there was neither sale nor power of purchase. The next thing to consider was the repaying to capital account of the £97,000 spent up to the 31st October last out of revenue. That must be replaced, and they ought to hold in hand a sufficient amount to carry them on to the end of this year, so that they would not be continuously coming to the shareholders suggesting fresh capital, though fresh capital would have to be raised if the business was to go on. They had been considering the matter, and thought the first issue ought to be about £300,000 or £350,000. The chairmain concluded his speech by inviting suggestions and remarks from the shareholders.

After remarks from shareholders,

Mr. Watson asked what injury was likely to ensue from the expiry of the patents, and if the directors were aware of the extent of the competition that was likely to arise.

The Chairman, replying, said that the first result of the expiry of the patents would be that whereas the National Telephone Company had previously had what was practically a monopoly, everybody could now interfere. Their policy, however, had always been to cover the ground—to be the man in possession—and though no one could foresee the result of their policy, yet the indications were strong that the loss in tne first instance by reduction of rate would be recouped by additional business. As to competitors at present there were none that they new of, excepting one starting in Manchester, then they had difficulty enough to get money, though their capital was only £43,000.

Replying to a question as to whether the new trunk line between London and Manchester would turn out profitable, and what the reductions in the provincial towns were,

The Chairman considered that although the trunk line at present was not much used there had been many inquiries, and he anticipated a good profit on this line. The reductions in the principal towns was from £15 to £10. They had not made any reduction in London, and for a very good reason, for while country subscribers only spoke within a mile, London subscribers spoke over a very large area. Expenses in London, too, were much higher. Although many complaints had been made as to the system in London it was chiefly on the ground of inefficiency of service, and not on account of the high rates.

Mr. Biden pointed out that a company whose working expenses were only 40 per cent., of its income invited opposition, and, indeed, opposition had already commenced at Manchester. He also wished the directors to publish weekly the receipts of the company, as was done by railway companies, together with a monthly return of expenses as compared with receipts. He thought the shareholders as much entitled to the information as the directors.

Replying, the **Chairman** pointed out that the proportion of working expenses would be much higher with a lower tariff, and he could not see any connection between them and the railway companies.

Some other Shareholders spoke, and the Chairman replied to them. The meeting was then concluded by the usual vote of thanks.

Maxim-Weston Electric Company.

Messrs. John Marks and James Hodgson, the liquidators of the above limited company, issued a notice to the shareholders, convening a meeting for the 22nd inst., to consider an offer for the purchase of the plant, machinery, and stock now at the works, Kingsland Green. In the notice the liquidators report as follows:—

"At the meeting held on the 7th of August last the resolution embodied in the company's notice of July 29th was duly carried, and our appointment as liquidators took place.

"After an investigation of the company's affairs sixty of the largest shareholders were invited to a conference at the offices, which was held on the 26th of August last. A few shareholders only attended, when it was pointed out to them that owing to the unfavourable state of the machinery market an effort should be made to prevent a forced sale, with its proverbial low prices and unsatisfactory results.

"At this conference, however, no definite result was arrived at, but a suggestion was made that the company should endeavour to affiliate with some already existing electric company, or as an alternative, that the liquidators should avail themselves of the earliest opportunity of selling the property to the best advantage.

"Upon inquiry the scheme of affiliation was found to be impracticable owing to the company's goods having been out of the market for so long a period, and for various other reasons, amongst which may be mentioned the rapid growth of the central station system. There was therefore no alternative but to await an improvement in prices and to open up communications with the leading firms and companies in the trade with a view of realising. Tenders were also invited by public advertisement for the purchase of the stock, machinery and plant.

"Owing to the continued depression in the market most of the offers received were of a very disappointing character, but from general appearances and taking into consideration the fact that heavy items are being daily incurred in respect of rent, taxes, salaries, and depreciation of plant standing idle, we are of opinion that the shareholders would best consult their interests by accepting the highest offer without further delay.

"We beg to point out that the meeting convened for January 22nd is *not* the meeting specified under section 142, part 4 of the Companies Act, 1862, at which a final statement of accounts shall be presented; but before exercising our powers as liquidators we thought it more satisfactory to lay the position of affairs before the shareholders.

"The shareholders will have heard with satisfaction the result of the actions 'Watt *v.* The Maxim-Weston Electric Company, Limited,' and 'The Maxim-Weston Electric Company, Limited, *v.* Watt,' upon which the liquidators of the *old* company will doubtless report to their shareholders."

The meeting to consider the proposal contained in the liquidators' circular, was held yesterday (Thursday) at Winchester House, Old Broad Street, under the presidency of Mr. Marks.

The Chairman explained the object of the meeting, and stated that a number of offers had been made to purchase the plant and stock of the Company at the Kingsland works. One of those offers was from Mr. Pryke for £2,000.

On the motion of Mr. Gooding this offer was unanimously accepted by the meeting.

Direct United States Cable Company, Limited.

Last Friday, this company held its twenty-seventh ordinary general meeting to receive the directors' report and accounts for the half-year ending the 31st December, 1890, and published in our last issue. Sir **John Pender** was in the chair.

The **Secretary** having read the notice convening this meeting and the minutes of the last previous one,

The **Chairman** said: Gentlemen, you have had the report in your hands for some days, and I presume you will take it as read, as you have usually done hitherto; while I, following up what I have done on the many previous occasions that I have had the pleasure of meeting you, will go over the figures of our report. This, gentlemen, will be almost all that I shall have to say to you to-day. The year has been commercially rather an eventful one, both in this country and in America. At the same time England has come out of it in a remarkably satisfactory way, and I hope that at the beginning of the new year we are making a new departure in commerce which will largely benefit our telegraph systems. There is a saying, often a true one, that "No news is good news," and as I have nothing very striking to say about what has been done during the year past, you may take it as a fairly satisfactory one, though it has not been so satisfactory as I could wish. I should like, gentlemen, to get back to 5 per cent. dividends, and the only way that I see to do this is to do our work better, and thereby encourage the further development of telegraphy between the old world and the new. The money earned to-day by Atlantic traffic is about the same in amount as it was when the tariff was very much higher than now, but other companies have come in to compete and to share that traffic with us, and the cleverest fellow is most likely to get the largest share of it. The company I have the honour to represent has done its work wonderfully well, and obtained its fair share of the Atlantic traffic, and so long as the gentlemen at present on this side of the table remain here, this will be the case. At the same time the public is apt to think that "new brooms sweep clean," and we have to contend against the new brooms and to show the value of that experience whereby the old broom is able to beat the new ones. I will now, gentlemen, consider the accounts. The revenue for the half-year ending 31st September, after deducting out payments, amounted to £43,347: the working and other expenses, including income tax, but excluding cost of repairs, amounted to £17,556, which left us a balance of £25,791 as the net profit of the half-year. This, with £968 brought forward from the last half-year, gives us a total of £26,759. This sum has been appropriated as follows: the interim dividend of 3s. 6d. per share for the quarter ending the 30th September last was £10,624; that for the quarter ending 31st December was the same, and a balance has been brought forward of £5,511. The revenue for the half-year shows an increase of £990, equal to 2½ per cent. as compared with that of the corresponding period for 1889. The working expenses in London have been so very nearly the same as in the corresponding period of last year, that no comparison need be made. The total shown by abstract A is £45 less than in 1889. Expenses of stations, as shown by abstract B, exhibit an increase of £1,866, due to two causes, first to our having now to bear the whole expense of the New York office instead of one-fourth only as in 1889. This, as I explained at our last meeting, accounts for the increase in the item, printing, stationery, and advertising account for the rest. The reserve fund, after deductions for cost of repairs and interest on investments, now stands at £252,678. The investments, as heretofore, continue to be worth much more than the figure at which they stand in the balance sheet. In July last, and on this day twelvemonths, I went very fully into the position of this company, so exhaustively, indeed, that on reading the two speeches this morning, I was rather astonished to find that I had taken up every point in the position of this company, and I satisfied myself that the best thing I could do to-day would be, after reading these figures to you, to tell you that I must wait for six months to get further information. In the meantime, you get the same dividends as last year, and for the last two or three years. I hope they will continue; I should be very much disappointed if they went backwards, but you may rest assured that it will require all our exertions to keep things going, for competition is very keen indeed. However, everyone is doing his best to secure for his company a share in the traffic. I am a strong believer in the increased telegraphy generally, and as to this company in particular, if we cannot get more than our neighbours, we shall, at any rate, try to get it. The chairman then moved the resolution.

Mr. **Marmore** asked about the probable results, favourable or otherwise, of the litigation referred to in paragraph 6, and

Captain **Jackson**, speaking on the same subject, thought the capture of the French cable one of the most disgraceful incidents in the history of Atlantic telegraphy, and that the pool directors had shown a great deal of supineness and want of diligence in not bringing this long-standing litigation to a speedier issue. It was this that neutralised all the efforts of the pool directors to share in the normal increase. There were three cables, one of which had been obtained—he would not say fraudulently, for that would be actionable—but by an intrigue with which the French themselves would have no sympathy if it were pressed, and he hoped the chairman would be able to satisfy the shareholders that there was no unnecessary delay. The shareholders were all eager to hear if there was any evidence that some result of the litigation was probable, because that was the chief cause of there being no improvement in the affairs of the company.

The **Chairman**, replying, said that he felt as strongly as the last speaker on this sublect, but he did not agree that this was the cause of their paying only 3½ instead of 5 per cent. It had, however, given an opposing company an additional cable.

The resolution approving the report and accounts was then put to the meeting and carried unanimously.

The usual vote of thanks concluded the meeting.

Anglo American Telegraph Company, Limited.—At a recent meeting of the Board of Directors, it was resolved to recommend to the proprietors at the next half-yearly general meeting of the Company, to be held on the 30th January next, the declaration of the following dividends:—1. A balance dividend of 15s. per cent. upon the ordinary consolidated stock, for the year ending 31st December, 1890. 2. A balance dividend of £1 10s. per cent. upon the preferred stock, for the year ending 31st December, 1890; both payable on the 31st January next, less income tax, to the shareholders registered on the books of the Company on the 13th instant. After paying the foregoing dividends, there will be an estimated balance of £844 to be carried forward to the next account. The above dividends, together with those already paid will amount to £2 17s. 6d. per cent. on the ordinary consolidated stock, and £5 15s. per cent. on the preferred stock, for the year 1890.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended January 16th, 1891, amounted to £6,09[illegible].

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 16th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,985.

The West India and Panama Telegraph Company. The receipts for the half-month ended January 15th, 1891, show a decrease of £405 as compared with the corresponding eriod.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Jan. 15).	Closing Quotation. (January 22).	Business done during week ending January 22, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101	98 —101	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	48½— 49½	49⅜	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	85½— 86½	85 — 86	86¼	85¾
2,809,310*l*	Do. do. Deferred	Stock	13¼— 13¾	13 — 13½	13½	13
130,000	Brazilian Submarine Telegraph, Limited	10	11¼— 11¾	11¼— 11¾	11⅝	11⅜
84,500*l*	Do. do. 5 p. c. Bonds	100	102 —104	102 —105	102¼	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	102 —106	102 —106	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2¼— 2½	2½	2¼
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2	1½— 2	1⅞	1½
$7,216,000	Commercial Cable, Capital Stock	$100	104 —105	104 —105	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	$\frac{7}{16}$— $\frac{9}{16}$	$\frac{7}{16}$— $\frac{9}{16}$	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11¾	11½
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	17	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜xd	10⅛— 10⅜xd	10⅜	$10\frac{3}{16}$
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼xd	14⅛— 14⅜xd	14¼	14
70,000	Do. 6 p. c. Preference	10	14¾— 15¼xd	14¾— 15¼xd	15⅛	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	105 —108	105 —108	106¾	105¾
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¼— 14½xd	14⅜— 14⅝xd	14⅝	14¼
320,000*l*	Do. 6 p. c. Debentures, repay February, 1891	100	101 —103	101 —103	...	...
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	103	102
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	102 —105	104	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —102	100 —102	101¼	101
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7 — 7½	6¾— 7¼	7⅜	7⅛
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	4 — 4½	3¾— 4¼	4⅛	$3\frac{15}{16}$
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¾— 2¼	1¾— 2¼	1¾	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9 — 9¼	9 — 9¼	$9\frac{3}{16}$	$9\frac{1}{16}$
180,042	Do. do. 6 p. c. Preference	10	14¾— 15	14¾— 15	$15\frac{1}{16}$	$14\frac{15}{16}$
150,000	Great Northern Tel. Company of Copenhagen	10	16½— 17	16½— 17	$16\frac{15}{16}$	16⅝
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105—108	106	...
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,800	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19¼	18¾
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9¼— 9¾	9¼— 9¾ xd	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾ xd	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£8 paid)	10	7¾— 8¼	7¾— 8¼	8¼	$8\frac{3}{16}$
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	$4\frac{11}{16}$	4⅝
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¼— 12¾	12½— 13	12⅞	$12\frac{11}{16}$
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10— 10½	10¼— 10¾	10½	10¼
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛— ⅜	$\frac{3}{16}$— $\frac{5}{16}$	...	...
9,000	Reuter's Limited	8	8½— 9	8½— 9	8⅝	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	110 —114	112 —115	113	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	5	4¾
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	44 — 46	46¼	44½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102	101 —103	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95	90 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	99¾	98½
130,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	3	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102	95 —100	97¼	...
64,174	Western and Brazilian Telegraph, Limited	15	10¾— 11¼	11¼— 11¾	$11\frac{9}{16}$	11¼
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6¾	6½— 7	6¾	$6\frac{11}{16}$
27,873	Do. do. do. 5 p. c. Deferred	7½	4¼— 4¾	5 — 5½	5⅛	4⅞
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	105½	104
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	2⅝— 2⅞	$2\frac{11}{16}$	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11¼— 11¾	$11\frac{9}{16}$	11¼
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3½— 4	3½— 4	3⅞	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2⅜—2⅝.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1¼—1¾.—Manchester Edison and Swan Company, £9 (£1 paid) 11s.—13s.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2⅜—2⅝.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—3½ per cent. (22nd January, 1891).

LONDON COUNTY COUNCIL.

ELECTRIC LIGHTING.

THE report of the Highways Committee, submitted at the last weekly meeting, stated that the council, on the 16th of December, authorised the committee to deal, during the Christmas vacation, with any matter within the scope of their reference which might require immediate action on the part of the council. Acting under this authority, they considered the undermentioned notices under the Electric Lighting Orders and Acts; and, subject to the conditions stated below in each case, have sanctioned, on behalf of the council, the works referred to in the notices, with the exception of those shown on plan No. 640 sent in with the notice marked (*a*).

(*a*) Notice (Registered No. 145), dated 25th November, 1890, from the Metropolitan Electric Lighting Company, of intention to lay mains in Theobald's Road (plan No. 637), Orange Street, Kingsgate Street and Fisher Street (plan No. 639), Wells Mews and Booth's Place (plan No. 640). That the company do give two days' notice to the council's chief engineer before commencing the works in any of the thoroughfares specified in the notice; that the mains be enclosed in 5-inch iron pipes, and be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving; and that the works generally shall be of the description approved by the council on 1st October, 1889.

(*b*) Notice (Registered No. 146), dated 25th November, 1890, from same company, of intention to lay mains in Garrick Street (plan No. 641). (Formal notice has been given to the company to lay the mains in the subway in Garrick Street.) That the mains be laid in the subway at the cost of the company, and enclosed in iron pipe; that the position to be occupied by the mains in the subway be subject to the approval of the chief engineer of the council; and that the work of placing them be carried out to his satisfaction.

(*c*) Notice (Registered No. 147) from the Notting Hill Electric Lighting Company of intention to lay a main across Kensington Park Road, from the north-east corner of Kensington Park Gardens to the south-west corner of Chepstow Villas West (1 plan). That the company do give two days' notice to the council's chief engineer before commencing the work; that the cover stones of the culverts under 20 inches wide shall be not less than 2 inches thick, and those of the wider culverts not less than 2½ inches; and that where the culverts cross the carriageway, there shall be at least 9 inches' thickness of Portland cement concrete above the cover-stones of the culvert in addition to the road material.

(*d*) Notice (Registered No. 148), dated 16th December, 1890, from the Kensington and Knightsbridge Electric Lighting Company of a proposed extension in Cromwell Gardens (1 plan). (No conditions necessary.)

CARETAKER, &C., AT ELECTRIC TESTING STATION.

We reported on the 30th September last that Mr. J. Somers, who on the preceding 18th of February was appointed at a salary of £2 a week to act as caretaker at the electric testing station at Cranbourne Street, has resigned his appointment, and that we had placed a person in temporary charge of the premises until the end of the year. We have received a report from the chief engineer stating that the conduct of the person referred to, Robert Simpson, has been satisfactory, and that he is careful, intelligent, and suitable for the position. We have seen Simpson, and concur with the opinion expressed by the engineer. We therefore recommend that Robert Simpson be appointed to act as caretaker and assistant to the inspector at the electric testing station at a salary of £2 a week, with rooms, coal, and light free.

NOTICES UNDER ELECTRIC LIGHTING ORDERS AND ACTS.

We have considered three notices from the Kensington and Knightsbridge Electric Lighting Company (Registered Nos. 149, 150 and 151). dated 23rd December, 1890, and 2nd and 9th January, 1891, respectively, with three plans of proposed extensions of mains in Brompton Road, Victoria Road, and Ennismore Gardens. These notices are for works of the usual character; and we recommend that the sanction of the council be given to the works referred to in the three notices (Registered Nos. 149, 150 and 151), dated 23rd December, 1890, and 2nd and 9th January, 1891, respectively, of the Kensington and Knightsbridge Electric Lighting Company.

We have also considered a notice (Registered No. 152), dated January 8th, 1891, with one plan, from the Brush Electrical Engineering Company, under the provisions of section 13 of the City of London Electric Lighting (Brush) Order, 1890, of intention to place a line of main conductors in the council's subways from the northern end of Blackfriars Bridge to the end of the subway near the Mansion House. Provision is made in the order for the payment of rent for the use of the subways, the amount of which will be a subject of arrangement, and there appears to be no objection to the work referred to being carried out under proper restrictions; but the plan submitted by the company only shows the route to be taken, and gives no details of how the work is to be done. We therefore recommend that the sanction of the council be given to the placing, by the Brush Electrical Engineering Company, of a line of main conductors in the council's subways, between Blackfriars Bridge and the Mansion House, in accordance with the company's notice (Registered No. 152), dated January 8th, 1891, on condition that details of the manner in which the work is to be done be submitted to, and approved by, the council's chief engineer before the work is commenced; and that all the work in, or in connection with, the subways shall be carried out, and any damage done to the subways in the execution of the work shall be made good, under the supervision and to the satisfaction of the council's chief engineer, and at the sole cost of the company.

SUBWAYS.

We have had before us an application from the Superintending Engineer, Post Office Telegraphs Department, for permission to suspend a wire in the subways of Shaftesbury Avenue and Charing Cross Road from Broad Street to Frith Street, for the purposes of a fire alarm call point, and also to make a connection through the lateral passage in the subway near D'Oyly Carte's Theatre, and to suspend a wire from that poiut to an existing connection with the subway in Cranbourne Street. We have received a report from the engineer, who states that he sees no objection to this being done; and we recommend that the sanction of the council be given to the laying, by the Post Office Telegraphs Department, in the subways of Shaftesbury Avenue and Charing Cross Road, of the wires and the making of the connections referred to in the application, upon condition that all the work be carried out and that any damage that may be done to the subways in its execution may be made good under the supervision and to the satisfaction of the council's chief engineer, and at the sole cost of the Post Office Telegraphs Department.

The Exchange Telegraph Company has applied for permission to make a connection between its line in the subway of the Victoria Embankment and the St. Stephen's Club House, and for this purpose to lay a wire in an iron pipe across the embankment. There appears to be no objection to what is proposed; and we recommend that the required permission be given to the Exchange Telegraph Company to make the connection referred to in the application, upon condition that the work shall be carried out, and that any damage done to the road and the subway shall be made good under the supervision and to the satisfaction of the council's chief engineer, and at the sole cost of the company. We have also, acting upon the authority above mentioned, acceded to an application made by the Superintending Engineer, Post Office Telegraphs Department, for permission to suspend a small telegraph cable through the subway in Charing Cross Road, from the northernmost point to No. 150 in that road, and to make a connection with the subway at the former point by means of a 3-inch pipe. We attached the condition that the work should be carried out under the supervision and to the satisfaction of the council's chief engineer, and at the sole cost of the Post Office Telegraphs Department.

The report of the Parliamentary Committee stated that they had considered the various bills deposited with the council in accordance with the standing orders of Parliament, and have received reports from the Parliamentary agent and from the engineer with reference to them. We now present our report on the several bills.

BOWMAN'S OXYGEN LIGHTING.

By this Bill it is proposed to authorise a company to lay down, maintain, alter, and remove mains in any street in London for the purpose of supplying oxygen according to a method described as Bowman's process. The Bill would confer general powers of opening and breaking up streets for the laying of pipes, &c., and of interfering with sewers and drains, similar to those of electric lighting companies and gas companies, and it will apply generally throughout the county. The area affected by the Bill is so large, and the possibilities of inconvenience which the works may cause to the public are so great, that the Bill will require most careful consideration. We have accordingly referred it to the Highways Committee, and have instructed the chemist to report on it, and we recommend that a petition be presented against the Bill, so as to afford the council an opportunity of opposing it if considered advisable.

CENTRAL LONDON RAILWAY.

This Bill provides for the construction at a deep level of an underground railway, extending from Shepherd's Bush Green along Uxbridge Road, High Street, Notting Hill, Bayswater Road, Oxford Street, Holborn, Newgate Street, Cheapside, the Poultry, and terminating at Cornhill; also of a branch railway extending from the northern end of Caxton Road, Hammersmith, to the commencement of the main railway at Shepherd's Bush Green. We understand generally that the scheme is practically the same as that of last year, except that its modifications remove certain of the former objections. The promoters have also inserted in the Bill the greater part of the clauses protecting the streets and sewers which were adjusted with them last year on behalf of the council after a great deal of consideration on the part of this committee and the officers of the council. The main arguments which were advanced against the scheme last year, and which led to its rejection by Parliament, were:—

(1) That the possibility of working such a subway advantageously by electrical traction had not been practically demonstrated.

(2) That having regard to the near approach of the completion of the City of London and Southwark Subway, it was desirable to postpone the scheme until some experience of actual working of that subway had been attained.

(3) That if the Oxford Street route were to be made available for an east and west railway through the centre of London, some railway system which would afford direct intercommunication with other railways in the suburbs of London might be preferable to a scheme of this kind.

Now that the working of the City of London and Southwark Subway has been commenced there will exist better materials than last year for a decision as to whether or not the extension of this subway system is expedient, and there is no doubt that any committee of Parliament to whom this Bill is referred will attach much importance to any resolution of the council on the subject. It will be remembered that the council, by resolution passed on the 11th March, 1890, confined its opposition to the Bill of last year to taking the necessary steps to protect the sewers and other interests of the council, and, with the limitation as to terms for the user of the subsoil referred to below, we see no reason to vary the former decision. We recommend that a petition be presented against the Central London Railway Bill, with a view to the protection of the sewers and other interests of the council, and for the insertion of clauses prohibiting buildings in advance of the general line, subjecting buildings over stations to the Building Act, and requiring the frontage line of buildings at the stations to be set back.

In connection with this Bill, our attention has been directed to the instruction given by the resolution of the council of the 30th September, 1890, in the following terms:—

"That it be an instruction to the Parliamentary Committee that with reference to any Railway or Subway Bill for compulsory powers to carry out works under streets in the County of London, the committee do consider whether a petition should be presented against such Bill, with a view to secure the insertion of proper provisions for payment of compensation to the public bodies in which such streets are vested, in respect of the beneficial user of the sub-soil of such streets by the railway or other company or persons using the same."

The present and future subway Bills of the class now under consideration come clearly within the scope of this resolution, and it will be necessary therefore that a decision should be arrived at now as to whether or not the proposition indicated in the resolution is to be put forward by the council in the case of these Bills.

It is generally understood that the position of a street is as follows:—

(1) *The surface* is open to public use as a thoroughfare for vehicles and pedestrians, and in some cases is partially appropriated for tramways. The maintenance and repair of the carriage and footway is legally vested in the vestry of the parish, or the district board of the district, who are understood to have the surface vested in them to such a depth as may be necessary in order that the ordinary operations of repair and maintenance may be carried on, and that the street may be maintained as a public highway.

It would probably be held that a similar authority is vested in the County Council in the case of main roads.

(2) *Beneath the surface*—

(*a*) The County Council in respect of main sewers, and the vestries and district boards in regard to local sewers, and apparently to any such depth as they may think necessary, have the right to construct and maintain sewers and sewerage works.

(*b*) The water company or companies authorised to supply the neighbourhood have the power to place mains, pipes, and other works, with authority to break up the surface for that purpose.

(*c*) The gas company or gas companies authorised to supply the neighbourhood with gas have the power to lay main pipes and works for gas purposes, and to break up the surface for that purpose.

(*d*) Electric lighting companies, and in part of London, a hydraulic power company have similar powers.

(*e*) Rights are also claimed by the Postmaster-General for placing wires, &c., in streets.

The powers of the Water, Gas, and Electric Lighting Companies are subject to the restrictions contained in the general Acts relating to those subjects, and in certain cases railway companies, under the authority of Parliamentary enactments, have been permitted to carry railways in tunnel or covered way. Subject to the various rights and interests which thus exist, the freehold in the subsoil is vested in the owner of the land. Where the property of the same owner is on both sides of the street his title to the freehold of the soil extends throughout the street and footways on both sides, and where a street forms the boundary between properties, the freehold would probably be vested in each owner up to the centre of the roadway.

In cases where works have been constructed under streets, claims have from time to time been made by the freeholder for purchase money on the ground that the subsoil is vested in him and cannot be entered upon by the promoters of public undertakings till it has been purchased from him in accordance with the provisions of the Lands Clauses Acts. But where such claims have been made and pressed, we believe it will be found that a nominal sum only has been awarded by way of purchase money, as it is obvious that having regard to the public and other rights existing in the surface and for some distance beneath it, the freehold of the subsoil has no practical pecuniary value to the owner.

It would, we think, be difficult to establish to the satisfaction of a Committee of Parliament that provisions ought to be inserted in the terms of the resolution for payment of purchase money to the public bodies in which such streets are vested, in respect of the beneficial user of the subsoil. But it is obvious that by the appropriation of the subsoil a commercial company obtains a privilege of great pecuniary value without any payment, while at the same time the extent of the subsoil is diminished which was available for sewerage and other works already authorised, and for additional works which may be authorised in the future to be made by local authorities. Under the existing law the Gas and Water Companies are subject to provisions under which when their profits reach a certain amount their charges must be reduced. Tramway and electric lighting undertakings have been made subject to an ultimate power of purchase by the local authority after the expiration of a certain period of years on terms defined by statute, and where, as has occasionally happened, a large street improvement and railway works have been concurrently executed, arrangements have been made for sharing the expenses between the local authority and the company. Having regard to these facts we are of opinion that measures should be taken to bring the matter under the consideration of Parliament, and we recommend That the council's petition against the Central London Railway Bill do contain a provision asking that clauses for the ultimate purchase of the undertaking by the local authority, similar to those at present contained in the Tramway Acts, may be inserted in the Bill.

City and South London Railway (Islington Extension).

This Bill provides for the construction at a deep level of an underground railway 1 mile 7 furlongs and 6 chains in length, commencing at a point in King William Street 20 yards north-west from the junction of Clement's Lane with that street, passing along King William Street, Princes Street, Moorgate Street, Finsbury Pavement and the City Road, and terminating at the north-west end of this road near the "Angel." The Bill also provides for the construction of a foot subway 7 chains in length, extending between the commencement of the above proposed railway and the existing station of the company under the junction of King William Street and Arthur Street East. The up and down lines of the proposed railway are intended to be placed in separate tunnels, each 11 feet internal diameter with enlargements for platforms at the stations, and it is proposed to afford access to the railway by means of stairs and lifts. The size of the foot subway is not stated. It will be necessary to petition against the Bill to secure protection to the sewers and other interests of the council, and the recommendation as to purchase made in the case of the Central London Railway is equally applicable to this undertaking. We recommend that a petition be presented against the City and South London Railway (Islington Extension), with a view to the protection of the sewers and other interests of the council, and for the insertion of clauses prohibiting buildings in advance of the general line, subjecting buildings over stations to the Building Act, and requiring the frontage line of buildings at the stations to be set back; and that the petition do contain a provision, asking that clauses for the ultimate purchase of the undertaking by the local authority, similar to those at present contained in the Tramway Acts, may be inserted in the Bill.

South Kensington and Paddington Subway.

This is a Bill for constructing a subway (near the surface) from South Kensington Station along the Exhibition Road and across Kensington Gardens to Bishop's Road, Paddington. The scheme is almost identical with that deposited last session and afterwards abandoned. The proposed subway will be constructed close to the surface, and will involve serious interference with sewers, also by occupying so large a space over the sewers will materially interfere with access to the same. The most important sewers liable to be affected by this subway are the Ranelagh Sewer and the Middle Level Sewer. The inconvenience during construction of the subway in consequence of the breaking up of the roads under which the subway is proposed to be made will be very great, and when completed the subway will monopolise a great part of the space under and close to the surface of the street, which space may be required for sewers, &c., and the council will probably think it right to oppose this Bill on preamble. In any case, a clause should be introduced to compel the company before commencing the works to submit to the council fully detailed drawings showing the method of constructing the subways, and of supporting the street both during the works and upon completion, and the company should be made to comply with and conform to all orders, directions, and regulations of the council with respect to these methods. The subway is also to be constructed close to the surface across Kensington Gardens, and during the works will be extremely detrimental to the use of the park by the public. We recommend that a petition be presented against the preamble of the South Kensington and Paddington Subway Bill, with a view to the protection of the sewers and other interests of the council, and for the insertion of clauses prohibiting buildings in advance of the general line, subjecting buildings over stations to the Building Act, and requiring the frontage line of buildings at the stations to be set back, and that the petition do contain a provision asking that clauses for the ultimate purchase of the undertaking by the local authority similar to those contained in the Tramways Acts, may be inserted in the Bill.

PHOTO-ELECTRIC CELLS.

By ROLLO APPLEYARD.

SOME years ago M. Becquerel published an account of experiments carried out by him regarding the action of light upon silver plates coated with bromide, iodide, chloride, and other silver salts, and showed it possible, in some degree, to obtain an electrical equivalent for actinic radiations cast upon them.

The next discovery of importance in this branch of electrical science was the fact that when selenium is exposed to the action of light, its electrical resistance is proportionately varied, and as a practical outcome, we have the ingenious photophone of Mr. A. Graham-Bell. The receiver of this instrument, it may be remembered, was an ordinary telephone, placed, for the original experiment, in a house at Washington, U.S. The telephone was connected through a battery and a selenium resistance back to itself. By means of a mirror situated in another house, the ray of light was directed upon the selenium resistance of the first station. The mirror now became the transmitter, and when spoken upon, caused a variation in the intensity of illumination of the selenium resistance, and a corresponding change in the current through the telephone.

It may be of interest to place on record the first message carried in this way along a sunbeam. To Mr. Tainter, who was listening intently at the telephone, Mr. Bell photophoned: "Mr. Tainter, if you hear what I am saying, come to the window and wave your hat;" the signal was promptly given; the ray of light had carried the spoken words.

From the date of these experiments little has been practically done in the field of photo-electricity. But much has been suggested. Was it not these that set some one (*Mr. Punch?*) first to ask: "When shall we *see* by electricity?" while others, possessed of telescopic imagination keener still, beheld the blessed vision of the Sun, no longer pouring his energies unrequited into space, but, by means of photo-electric cells and thermo-piles, these powers gathered into electric storehouses to the total extinction of steam engines, and the utter repression of smoke.

This week, however, another chapter in the history of photo-electricity has been furnished to us. Prof. George M. Minchin has published the results of his work in that direction, which has extended over a period of 14 years. He provides us with several kinds of cells. The latest constructed is one giving an E.M.F. of more than ½-volt when exposed to ordinary diffused daylight, and which he has distinguished as "a *seleno-aluminium* cell." Another (tin-foil) is externally similar to this, but possesses a remarkable, indeed a paradoxical quality, in virtue of which it is known as an "*impulsion cell.*"

The resistance, it should be stated, of either form of cell is to be measured only in megohms, so that the amount of power actually available is not much.

To make the seleno-aluminium cell, a small plate about 15 mm. long by about 2 mm. in width is first cut out of a sheet of aluminium. There is, however, no limit to the size of the plate. Its surface should be quite clean and smooth. Make a small pin-hole near one end of it, the object of the hole being to suspend the plate when finished by means of a platinum wire. Having done this, place it on a porcelain or earthenware plate resting on a tripod, with a low Bunsen flame underneath. Then take a hot glass rod with a "blob" of melted black selenium on it; and seizing the aluminium plate by a pair of forceps, while the plate still rests on the earthenware slab, smear the "blob" of selenium over the aluminium surface, so as to produce a thin, uniform, shiny black layer. Then instantly, by means of forceps, remove the plate and work it up and down a few times in the air, to cool it a little, at the same time removing the Bunsen flame from below.

Then replace the aluminium plate on a comparatively cool part of the porcelain. If there is any tendency of the selenium to become again liquid, check it by blowing over its surface. Then work the Bunsen flame rapidly to and fro underneath the porcelain tile, occasionally blowing over the surface of the selenium. This will produce a gradual change in the colour of the selenium layer. The shining jet black will first become a bluish white, and, as the heating and blowing process is continued, the surface will assume a sombre grey, which may be of several kinds.

If it is a very light grey it is not the most sensitive surface. If it is a grey with a very slight violet tinge it is not the most sensitive surface, nor if it contains any glossy spots or streaks; and in either of these cases the flame must be applied, the selenium re-melted, and the process begun from the beginning. The final surface to be attained is one which is a dull greyish, but decided *brown*—in appearance not unlike the head of an ordinary safety match. That is the most sensitive surface.

When this is attained the plate is screened from the light, and left to cool on the porcelain slab for about ten minutes. Then the plate may be suspended from a thin platinum wire and sealed into a glass tube containing acetone, in the presence of another plate of aluminium, the size of which may be extremely small, and which is also held by a platinum wire fused into the glass. The two platinum wires pass through the opposite ends of the tube and from the poles of the cell.

The acetone completely covers both plates and junctions. On exposure to light the sensitive plate is negative toward the second plate; and the E.M.F. developed in every part of the spectrum is of very considerable magnitude, the maximum occurring in the yellow. For instance, the diffused light of one of the recent foggy days gave with one of these cells an E.M.F. of about a quarter of a volt.

The cell differs from all other photo-electric cells in its great range of sensitiveness in the spectrum, almost all others confining their effects to the blue. It is this characteristic which makes it an approximation to an electric photometer.

The "impulsion" cells next to be described on exposure to light may exhibit no E.M.F. at all, to begin with. But after a slight tap has been administered to the support of the cell, it will be found to do so; another slight tap will make it revert to the insensitive state, and so on. Instead of this gentle mechanical tap, the sparking of an induction coil at a distance will change the plate from the insensitive to the sensitive condition, but not the reverse, and this effect has been observed at as great a distance as 81 feet.

Prof. Minchin has named these cells "impulsion" cells, from this susceptibility to mechanical and electrical impulses. He forms them from a strip of tin-foil ¾-inch long and ⅛th-inch wide. This is first cleaned in sodic hydrate, and then in dilute hydrochloric or hydrofluoric acid, and thoroughly washed in distilled water. It is then placed on a glass plate in an oxidising solution:—

500 cc. of distilled water.
3 cc. nitric acid.
15 grammes ammonic nitrate.

After four minutes, the surface being covered with a white deposit, the solution is removed from under the glass plate, which is fixed. A spirit lamp is then applied to the under surface of the glass plate until all the water has evaporated, after which the surface of the plate passes through a series of states, in some of which it is sensitive and in some insensitive to light; and, finally, the tin plate has a superficial coating of a white substance—probably the binoxide of tin. It is then immersed in a glass cell containing methyl alcohol (prepared from wintergreen), in front of another clean tin plate, both being suspended by platinum wires and sealed into a glass tube. After some days many of these cells develop "impulsion" results.

Whatever may be the cause of the curious behaviour of impulsion cells, it is certain that it is not a matter of loose contacts at the junctions with the platinum wires. A loose contact is incapable of causing a *regular* cycle of changes; and as an experimental proof that it is nothing at all to do with loose contacts, Prof. Minchin possesses a cell which is an impulsion cell at one part of its surface, but which behaves as a simple sensitive cell for the remaining portions. By attaching a contact arm to an electrometer needle, and connecting photo cells to the quadrants, the light of a taper is sufficient to cause contact to be made, so that ultimately a practical use may be found for the cells. The actual needle used is shown in the figure; it is carried on a glass arm, A. The wire, *c*, is the charging wire for the electrometer needle. The wire, W, connects the mercury cup, M, with the platinum knob, P; B is a light platinum spring. This form of contact arm, which was designed by the present writer, provides good insulation for the needle. At first it was found that "stixion" occurred at each contact, due, apparently, to heating and consequent welding at the touching point. As this did not disappear when a condenser was interposed, a much less current was employed in circuit with a relay, which disposed of the difficulty.

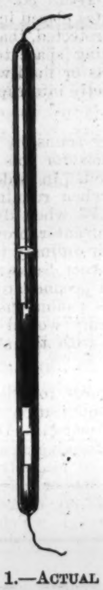


FIG. 1.—ACTUAL SIZE.

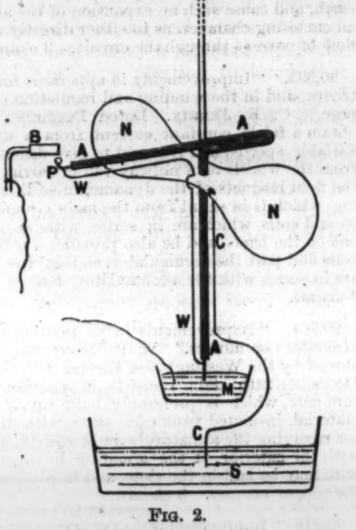


FIG. 2.

☞ Prof. Minchin puts before us three objects to be attained in photo-electricity. "First, the construction of an electric photometer which will enable us to compare, in a rational manner, the intensities of different lights as regards each of their individual colours. The second, 'Telephotography,' that is, 'seeing at any distance by means of electricity.' The third is the utilising of solar energy for the purpose of doing work without the consumption of terrestrial materials. The objection usually raised to this is, that there is not energy enough in the solar rays, received at the surface of the earth for the purpose. That objection is founded on the experiments of M. Pouillet, but I deny the validity of the inference from his experiments, because he assumes that the amount of energy in the solar rays is to be determined by allowing them to fall on the blackened surface of a pyrheliometer. But clearly the assumption that all forms of energy of the solar beam are caught up by a blackened surface, and transformed into heat, is one which may possibly be incorrect, so that even on this score alone there is hope for the solution of the problem."

Cooper's Hill College.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1889.

19,153. "Improvements in phonographs." G. G. M. Hardingham. (A communication from abroad by Thomas Alva Edison, of America.) Dated November 28th. 8d. One feature of the present invention consists in attaching both the recording point and the reproducing point to the same diaphragm, and in so arranging the parts carried by such diaphragm, that by a simple movement either the recording or the reproducing point may be brought into operative position. 9 claims.

20,311. "Improvements in or relating to lightning arresters." W. P. Thompson. (A communication from abroad by the Westinghouse Electric Company, of America.) Dated December 17th. 8d. Consists of one or more pairs of discharge points or plates placed in such relation to each other, and to the circuit to be protected, that the lightning discharge will pass across the intervening space to the earth, and cause such an expansion of the air or a gas or fluid within an enclosing chamber, as to either directly or indirectly interrupt the flow of current through the circuit. 3 claims.

20,393. "Improvements in apparatus for lighting trains by electricity, and in the winding and regulation of dynamos for this purpose." C. F. Jenkin. Dated December 18th. 8d. In order to obtain a fairly constant current from a dynamo when running at variable speeds, and required to give different E.M.Fs when driven from the wheels of a railway van or carriage, the inventor provides the field magnets of the dynamo, in addition to their ordinary winding, which is in shunt from the main circuit, with other backwardly wound coils, which are in series, with an electrical accumulator on one of the leads, and he also provides a resistance as a shunt past the coils and past the accumulator, so that the backwardly wound coils are in series with the accumulator, but in parallel with the shunt. 3 claims.

20,764. "Improvements in or relating to armatures for electric generators or motors." W. P. Thompson. (A communication from abroad by the Westinghouse Electric Company, of America.) Dated December 24th. 8d. Consists, in general terms, in forming an armature core, which is preferably built up of laminæ of magnetisable material, insulated from each other, with diverging slots or openings for receiving the armature wire or ribbon, which slots are connected with the exterior of the armature by openings through which the wire may be laid in the slots, and in placing the wire in such slots in the proper manner. 3 claims.

20,918. "Improvements in or appertaining to self-regulating dynamo-electric machines, and improvements in the method of generating and maintaining thereby electric currents of constant, or approximately constant, quantity in circuits of varying resistance." W. P. Thompson. (A communication from abroad by W. Stanley, jun., of America.) Dated December 31st. 8d. The purpose of the present invention is to produce the required variations in the electromotive force for delivering a constant, or approximately constant, current by causing variations in the resistance of the work circuit to occasion sufficient changes in the inductive actions taking place between the armature and field magnet to vary the number of lines of force cutting the armature coils proportionately to the variations in the electromotive force required. This is accomplished by developing opposing magnetic potentials on the part of the field magnet and armature, and permitting the excess of the former to develop resultant lines of force which thread through or cut the armature coils, and by varying the magnetic potential of the armature by the variations in the phase, time, and strength of the current flowing in the coils, so that the excess of the effective magnetic potential of the field magnet above that of the armature will vary directly as the work being done. From this it will follow that the number of lines of force threading the armature coils will vary with variations in load. 4 claims.

1890.

3,984. "Improvements in or connected with shades, globes, or glasses for electric or other lights." J. A. Duval and A. H. Nelson. Dated March 13th. 6d. The shade, bulb, globe or glass is provided with an envelope or covering of beads of crystal or of glass, cut in facets or smooth, and of any desired shape or shapes, size or sizes and colour or colours, which beads are strung upon threads, or as we prefer upon metallic wires, in such a manner as to constitute an envelope to enclose or surround the shade, bulb, globe or glass. The threads or wires are attached to a bottom ring, and constitute meridians on which the beads are arranged according to size in such a manner that the envelope shall conform as closely as practicable to the shape of the shade, bulb, globe or glass. The threads or wires are attached at their upper ends to two curved arms or parts hinged or jointed together in such a manner that when these are open the shade, bulb, globe or glass to be covered can be introduced into the envelope from the top and side, after which the said arms or parts are closed on to the collar or rim of the socket surmounting the shade, bulb, globe or glass, the arrangement being such that in case of breakage of the latter, the broken glass will be retained by the envelope. 1 claim.

5,087. "Improvements in electric conductors or cables." H. H. Lake. (Communicated from abroad by J. A. Barrett, of New York.) Dated April 1st. 8d. Consists primarily in an electrical conductor, so covered with a fibrous or other separating medium, as to afford in the covering numerous interstitial air spaces, around which is placed a non-inducting envelope capable of confining the air in such spaces, and of retarding or preventing the application of the sealing material from driving out the air originally enclosed within the insulating structure. The invention further consists in two or more wires made up in a group, each wire being covered with fibrous or meshed material containing air, with a non-conducting envelope surrounding the group, capable of retarding or preventing the expulsion of the air by the sealing material when it is applied in the manufacture of the cable. The invention further consists in a cable in which are assembled the individual conductors or groups of conductors, independently covered as above described, by a fibrous meshed or honeycombed covering surrounded by a non-conducting envelope, whether or not an external armour of lead or other material is employed. 7 claims.

6,581. "An improved method of renewing the carbon filaments of incandescence electric lamps." H. H. Lake. (Communicated from abroad by La Société L'Incandescence Electrique, of Paris.) Dated April 29th. 6d. Claim:—The method of repairing or replacing the carbon filaments of incandescence electric lamps, which consists in introducing into the bulb of the lamp a new filament, a liquid hydrocarburet for connecting the extremities of the aforesaid filament with the joining pieces formed by the ends of the broken filament, which are adapted to receive the same, substantially as and for the purpose described.

7,209. "Improvements in electric arc lighting." L. Saunderson. Dated December 4th, 1889. (Under International Convention.) 8d. The object of the invention is to produce an intense yellowish-white light of great illuminating power in foggy as well as in clear weather between the electrodes of the arc lamp, by adding to the arc flame light-rays of long wave length, in which rays the arc light, as usually exhibited between carbon electrodes, is deficient. This end is attained by supplying to the arc a minute quantity of highly-heated carbonaceous vapour. 4 claims.

CORRESPONDENCE.

Some Experiments with Incandescent Lamps.

In the course of some experiments I was trying a few days since with a frictional machine, I happened to have a few burnt-out incandescent lamps lying on the table beside me; out of curiosity to see what result, if any, would follow, I took one of these and having attached a piece of chain to the prime conductor of the machine, I suspended the lamp by one of the bottom loops to the last link of the chain; turning the handle, I noticed that occasionally the lamp appeared to be filled with a kind of phosphorescent light. Continuing to turn the handle with one hand, with the other I took a spark from the prime conductor, when, to my astonishment, I noticed the lamp was again brilliantly lighted up; I tried this over and over again with a like result. I then detached the lamp from the chain and holding it in my hand, charged it in the same way as you would charge a Leyden jar. I then stopped the machine and on touching the loops with the finger of the other hand the lamp was not only lighted up again in the same way, but I received a very severe shock. I charged the lamp again and found that I could carry it to any part of the house and light the gas with it simply by holding the lamp above the gas burner and touching the loop with the forefinger of the disengaged hand. I did the same thing frequently afterwards, taking the charge from a link belt which was driving a dynamo. I carried the lamp through the mill and back to the engine room, where I lighted the gas in the same way. I may mention that these experiments were carried out during the late severe frost when the atmosphere was, of course, exceptionally dry.

W. Scott Elliot.

January 20*th*, 1891.

The St. James's and Pall Mall Electric Light Company.

Referring to the article in the current issue of your paper, on the "St. James and Pall Mall Electric Light Company, Limited," would you be kind enough to answer the following questions :—

(1) Whether the efficiency supply, = 97·5 per cent., is correct ?

(2) Is the loss of energy in mains covered by 2·5 per cent ? As it seems an extraordinary result.

Russell F. Ferguson.

January 19*th*, 1891.

[The Company's officials will doubtless answer the questions put by our correspondent.—EDS. ELEC. REV.]

Force, Energy, Power, &c.

Will you kindly note that in my letter of last week, "it would not be so if time exceeded *unity*," has been misprinted "units," and be good enough to make the correction.

Jas. McLachlan.

Elmore's Copper.

With reference to my previous letter to you on the subject of the Elmore process, I have been very glad to see that Mr. Stepney Rawson, whose standing and technical knowledge of the subject of deposition of metals no one can challenge, has taken up the matter, replying to the technical points raised by you against the process. On the eight points that Mr. Stepney Rawson has, I think, shown you to be mistaken in, I need not touch, but I should like to add that you do not seem clearly to comprehend the all-important fact that Elmore produces in the one process of refining the copper a manufactured article, thereby increasing very enormously, by practically no additional expense, the value of the raw and now refined material. I am sorry, however, that Mr. Rawson has not dealt with that part of your article treating with the financial policy of the Elmore companies. His reason for this may be that he has confined himself to the technical questions only and not to the financial questions, for which probably his brother is responsible. I would like to point out, from my own knowledge, I having been financially interested from the commencement, besides having a good knowledge of what was being done from time to time, that, besides the original companies, no subsidiary Elmore company was brought out until the works at Leeds had been erected, and the invention had been proved on a commercial scale. If any further time had been wasted in developing the foreign patents, those responsible for the formation of the companies and for the exploitation of the patents abroad would have been greatly to blame ; for, as is well known, patents have only a certain time to run, and rival manufacturers are only too keen to take any advantage possible to depreciate the value of patents or processes in their respective countries, and I consider it a feather in the cap of those connected with the companies that the patents for France, Austria, and Germany should have been already placed, and arrangements made on a large scale for manufacture. The head of one of the largest electrical businesses in England stated at the end of last week that it seemed to him that the ELECTRICAL REVIEW were technically quite unacquainted with the present state of electro-depositing, and that they were basing their arguments upon the state of the trade some few years ago. I myself think that you can be little aware of the enormous extent of the copper industry. As a result of my enquiries, I find that the average production of copper articles of seven different concerns is no less than 73 tons per week each, while, of course, there are many other firms in the industry whose turnover I am unacquainted with. Now, the Elmore process is applicable to practically every copper article that is manufactured, and it is claimed by Mr. Elmore that any copper article can be manufactured, including strips and thick wire, such as is used for electric lighting purposes, at the cost of under 1d. per lb. above the cost of raw copper. The cost of copper articles varies from about 2½d. per lb. up to many shillings per lb. above the cost of raw copper, and there is a very large business done in articles averaging 2s. per lb. above the cost of raw copper, which price was that taken in the original Elmore prospectus for the expensive articles, so that you see that whilst splitting hairs as to whether the cost of the Elmore process is 1d. per lb. or 2d. per lb. above the cost of raw copper, you lose sight altogether of the question that, even were the cost of the process as high as 6d. per lb. above the cost of the copper, there would be an enormous profit for many articles of regular daily consumption. I sympathise with those who think that we ought to be allowed to view the Elmore process in actual work, but I can but take the reply that has been given me by the company, namely, that apart from the question of the loss of time to officials, they are constantly making new improvements and discoveries which they are applying on a large scale, and therefore it would be injudicious for anyone to see the works at the present moment. I would further mention in this connection that there are many firms and companies in the trade who rigidly refuse admittance to their works, and very rightly too. I am myself content to rely upon the word of such well-known men as have seen the works, and who have been satisfied with them, such as M. Sécretan, whose knowledge of the copper industry places him *facile princeps* in the copper trade, and whose integrity and honesty are now admitted by even his worst enemies, to say nothing of such men as Dr. Hopkinson, Major Jones, who was for many years head of the most important department of Sir William Armstrong, Mitchells & Co. ; Major General Fraser, who was the head of the Royal Laboratory at Woolwich and the Small Arms Factory at Enfield ; Mr. Rock, Chairman of the Phosphor Bronze Company ; Sir James Mackenzie, who held a very important position at Armstrong, Mitchells & Co.'s works in Italy ; and Mr. George Holmes, the Secretary of the Institution of Naval Architects and a well-known writer on engineering subjects ; and in addition to all these we have the testimony of the two Mr. Rawsons, who have identified themselves with the process, and Messrs. Parker, Simmons, Sprague, and others, who were interested in the company originally, or reported upon the process. Furthermore, I am in a position to know that those who are the most competent to judge of the future of the companies have been and remain the largest shareholders.

An Original Shareholder.

[The writer of this epistle is the same youthful believer in assertions to whom we administered a well-meant little sermon on credulity in our issue of October 10th, p. 415. As the present communication appears to be on the same lines as that which appeared in the number of the REVIEW above mentioned, and as most of the names quoted have already been made familiar in our articles on the subject, we need not at the moment make any further comments beyond stating that "An Original Shareholder" and his clique are probably the only persons in existence who have such implicit confidence in Mr. Stepney Rawson, and so little in ourselves, as his first paragraph implies.—EDS. ELEC. REV.]

Electric Railways.

I am pleased to note in the issue of your most excellent paper of December 26th, 1890, that you have done me the honour of publishing the paper which I read before the Chicago Electric Club, November 17th, 1890.

The *Street Railway Journal*, published in New York City, and being the leading paper of its class in this country, published in the December, 1890, number of their paper an editorial comment or criticism upon my paper. The criticism was so manifestly unfair and unjust, that I felt called upon to reply to it, which I did, and my letter to them is published in the January, 1891, number of their paper. For your information I enclose you herewith : (1) A type-written copy of their editorial ; and (2) a type-written copy of my reply.

It occurred to me that these papers would at least be of interest to you, and, possibly, that you might wish to reprint them in your paper.

Thanking you sincerely for the compliment and honour conferred upon me, as indicated above,

I am, very respectfully,

Theo. P. Bailey.

Chicago, *January 8th*, 1891.

Copy of Editorial taken from the December, 1890, *Number of the "Railway Journal," published in New York City.*

ELECTRICITY *v.* CABLE.

In a paper recently read before the Chicago Electric Club, Theo. P. Bailey makes the following statement :—"Several railway companies which adopted the cable system before the possibilities of the electric system were fully appreciated or understood, are now seriously considering the complete displacement of that system and the substitution of electricity in its stead. I have no doubt that some bright representative of the electric system will persuade our cable friends to join the procession of progress, abandon the cable, welcome and adopt electricity as the motive power, and thus preserve the independence and stability of his street railway system." Such statements sound very nice on paper, or would, if they were true ; but we have yet to learn of any company that contemplates such a change. Statements like the above do more harm than good to the cause of electric traction. No matter how much we may all wish that electricity might at once be adopted as the universal motive power for street railways, we know from the very nature of the case that it cannot be done. Nearly every street railway line in operation or building presents a different problem for the engineers to solve. To a few the cable is best adapted, to others electricity, and to others horse-power. Several important lines are about to be equipped with cable, on every one of which the management would prefer to employ electricity, but in the present state of the art they do not feel safe in doing it. Are we to infer that they are fools "above all men" because they adopt the cable system. By no means ; we give them credit for being honest, and for doing what all would do if placed in their position and knowing all the facts. We do not believe that there is an electric company in the country that would undertake to equip with electricity such lines as Third Avenue and Broadway, New York, or Pennsylvania Avenue at Washington, if they were to manage the lines and be held responsible for their economical working for the next five years. However much anyone may entertain the hope expressed in the paper named above, that horse, cable or steam power will be numbered with the events of the past, and that electricity will claim supremacy, we do not believe that cable railway managers nor those contemplating the building of such systems are giving themselves very much concern over the possibilities of such an event.

Copy of Mr. Bailey's reply published in the January, 1891, *"Street Railway Journal" of New York.*

(As we have many times stated, our columns are open to any who have anything to communicate, and especially are they open to any who may at any time feel that through some utterance of ours, or some mistake, they may not have received entire justice. Under these circumstances we are very glad to print the following letter which relates to some editorial comment in our last issue.—ED.)

Chicago, *December 20th*, 1890.

Editors "Street Railway Journal."

Gentlemen,—It has been my pleasure to read the December number of your very excellent journal, and to note its editorial comments upon certain statements in the paper which I read a few weeks since before the Chicago Electric Club on the subject of electric railways.

I am truly glad to know that there was something in the paper worthy of the consideration of thoughtful people, and am not surprised to find some who are unwilling to accept the predictions made as to the future of electricity in the problem of surface and elevated railway transportation, but I do regret to see that I am credited with exaggerations and misstatements in order to score a point or a victory for electricity, and at the same time strike a blow against the cable.

When I stated that several railway companies which had adopted the cable system before the possibilities of the electric system were fully appreciated or understood, were now seriously considering the complete displacement of that system, and the substitution of electricity in its stead, I had indisputable evidence of the fact before me, and that evidence is still in my possession. It is a notable fact that electricity is now being used on many roads where two or three years ago it was contemplated the cable system should be used. In fact, at that time nothing but the cable system was considered for these particular cases.

It is also a fact that several cable railway companies have used electricity instead of cables in equipping extensions or new lines, and I have no doubt others will do likewise in the future. The principal reason why there has not been a general movement in this direction is that the desired franchises for overhead wires could not readily be obtained. Cable railway companies in four of our leading western cities are now arranging to supplant their cable with the electric system, and I have no doubt that within one year the final arrangements and contracts will all be closed.

Mr. Frank Van Vleck, of Los Angelos, recently read a paper before the American Society of Mechanical Engineers, in which he said :—"The writer, although connected with the development of the cable system, cannot but conclude that the day of usefulness for the cable has for ever gone, and that the electric road stands the champion in the field."

Mr. Thomas Lowry at the last meeting of the American Street Railway Association, said that he was so thoroughly convinced that electricity is the coming power for street railways that this was the last convention that would ever seriously consider horses for the operation of street railways.

It is not surprising that the management of all cable and horse railway companies do not abandon their present method of propulsion and substitute electricity, for it must be remembered that the latter is the junior member of this trio of motive powers for street railways, and its superiority and advantage must be proven beyond the possibility of a doubt before its seniors will give way to it. Examine the statistics of the past two years, however, and I believe you will agree with me that it is rapidly and permanently making up a record upon which the verdict of the public will be substantially a unit in its favour.

The facts as they are shown to-day do not warrant or justify the division of business between the electric, cable, and horse railway systems, as stated in your article, for it is universally conceded that the latter method has practically become obsolete so far as future installations are concerned, while the cable system has no advocates, except for large cities, where overhead wire privileges cannot be obtained, and places where the gradients are so excessively heavy that adhesion cannot be relied upon in ascending them. In all other cases, and under all other circumstances, the electric system stands unexcelled and supreme.

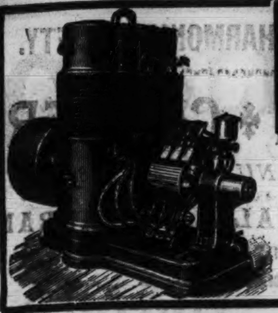
In counter-distinction with your proposition or statement that no electric company would undertake to equip with electricity such lines as Broadway and Third Avenue, New York, or Pennsylvania Avenue, Washington, &c., I speak advisedly when I say that I know of at least one electric company who would be very glad of an opportunity to equip any one of the three roads mentioned, with the guarantee that the percentage of operating expenses should be less with electricity than with any other known system of motive power for traction purposes. I am not certain but that there are at least four other companies who would willingly accept a similar contract.

I do not believe that there is a point on Broadway or Third Avenue, in New York City, where a greater number of cars pass in a given time than at the corner of Winter and Tremont Streets, in Boston, where the electric system is employed on the West End Road in that city. No one has ever doubted or questioned the complete success of this electrical installation, and anyone familiar with the situation there will concede that it operates under conditions of a most adverse character, and that such a combination of unfavourable circumstances affecting the operations of an electric road cannot be found in any street railway system in the United States.

Trusting that you will do me the favour to give this letter a place in the January number of your journal,

I am, with respect,

THEO. P. BAILEY.



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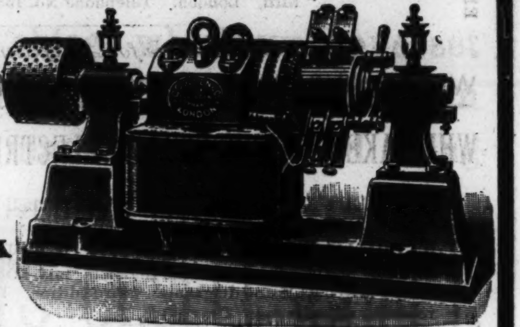

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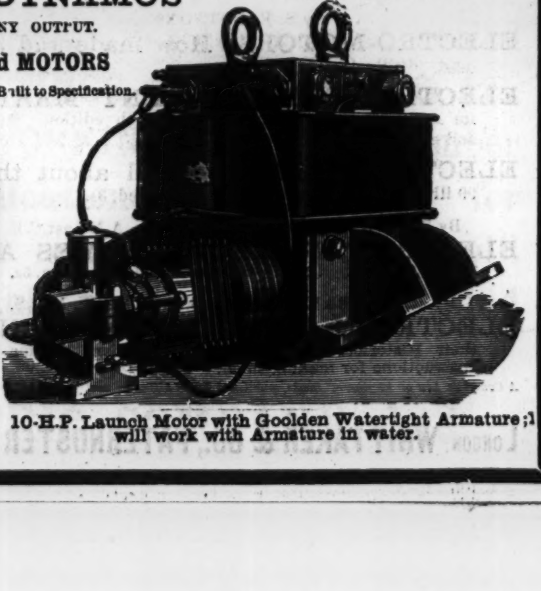

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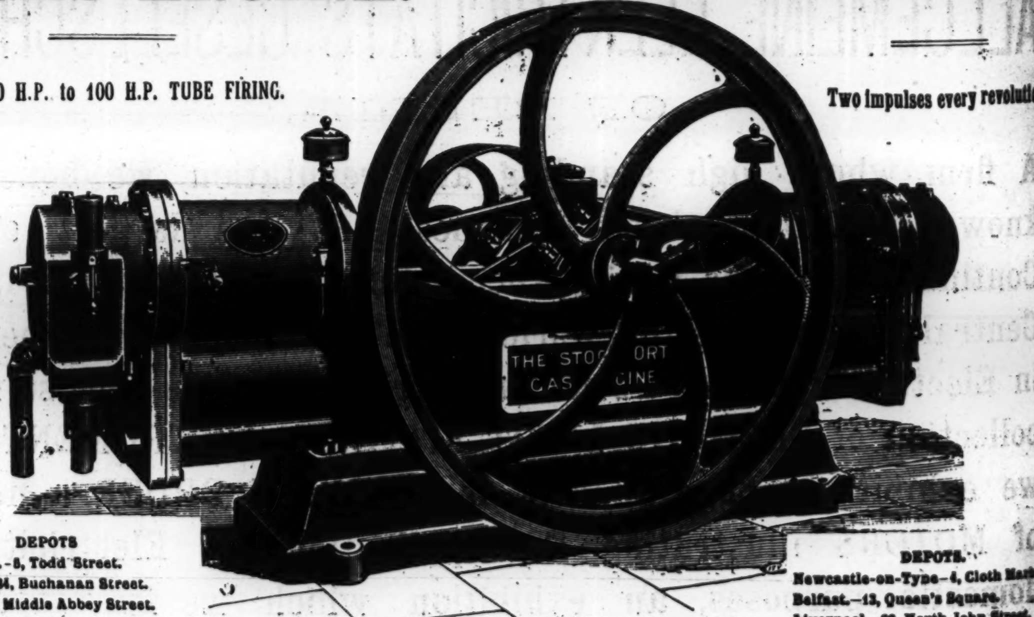

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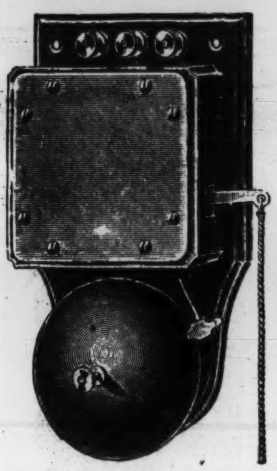

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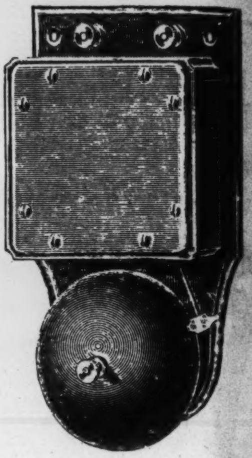

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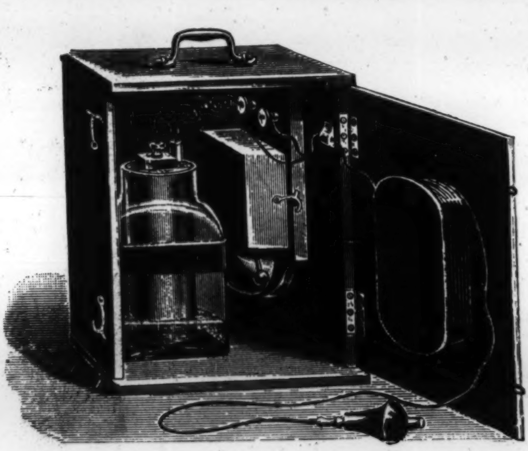

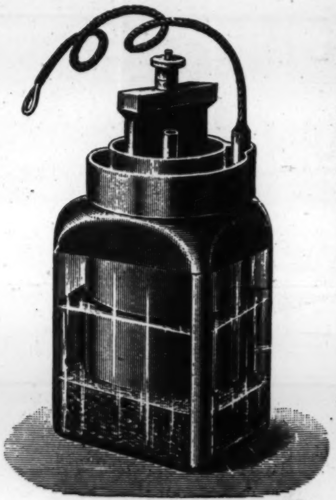

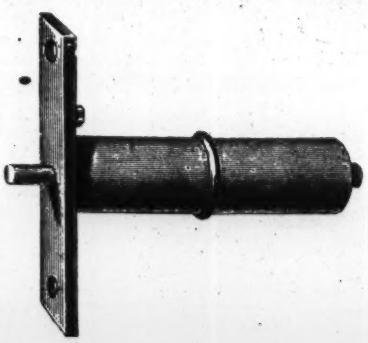

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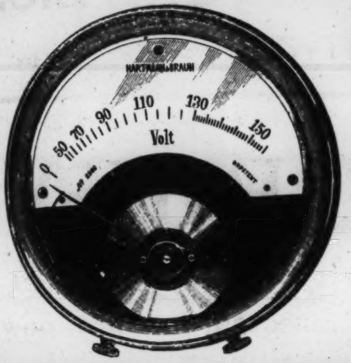

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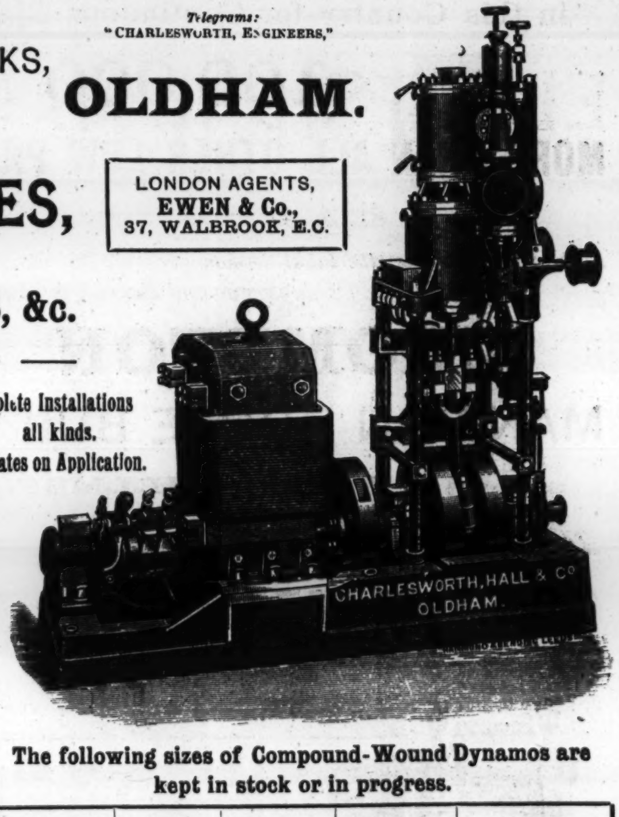

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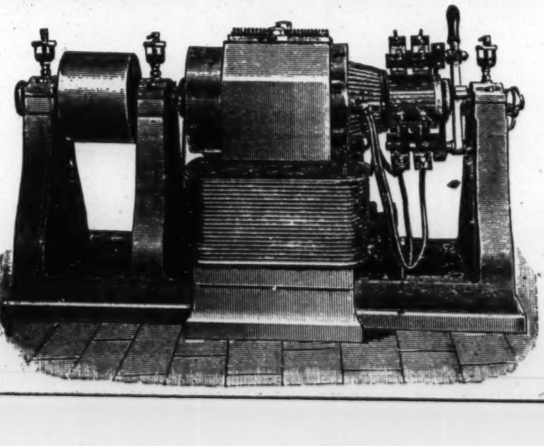

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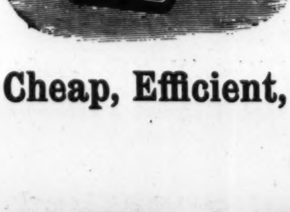

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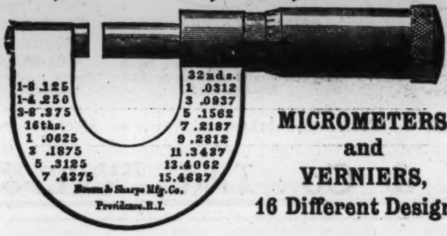

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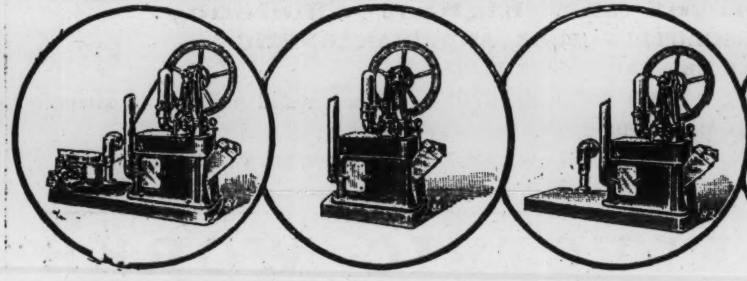

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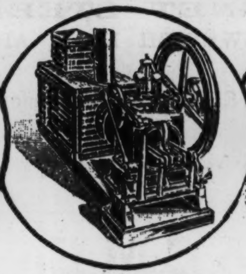

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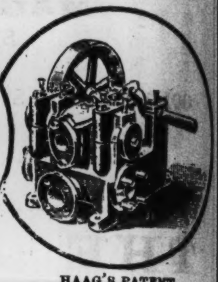

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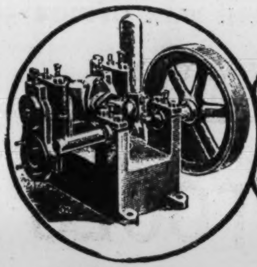

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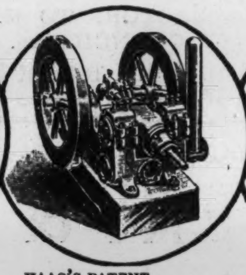

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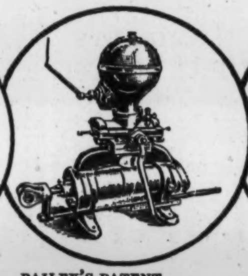

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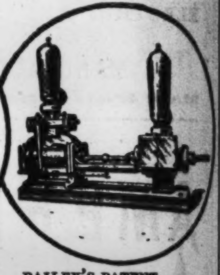

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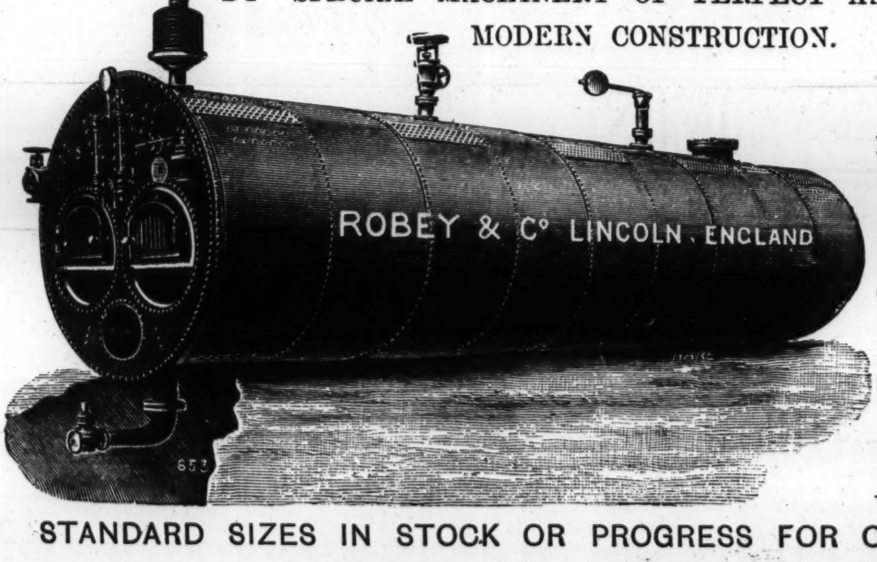

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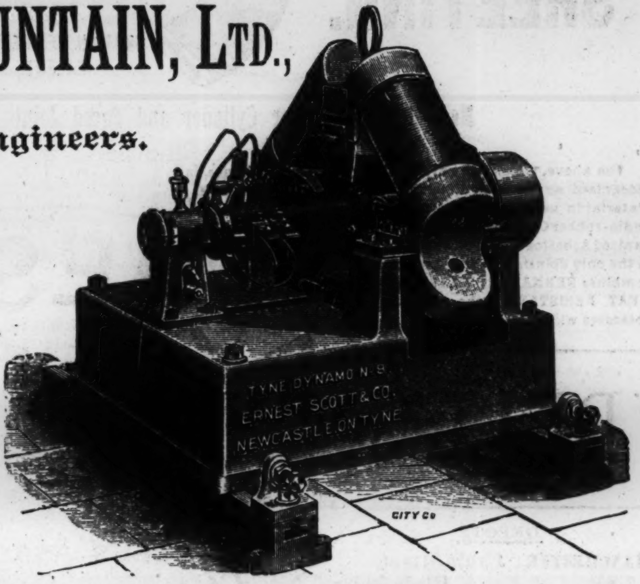

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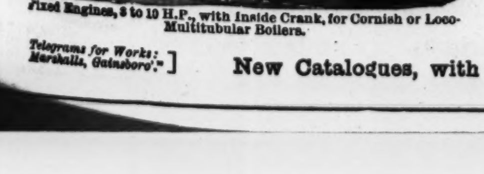

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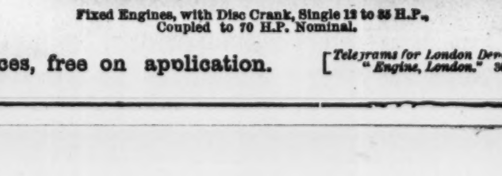
Vertical Engines for Ship Lighting and Small Installations.



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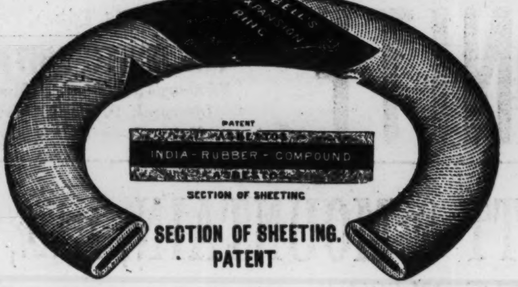
EXPANSION SHEETING.



SECTION OF SHEETING.
PATENT

EXPANSION RINGS.

Made from 1-Ply for Cylinder and Faced Joints to any thickness for uneven surfaces.

The above, which can only be obtained from this house, is recognised as the Most Efficient and Economical Jointing Material in use. It is composed of a specially-prepared India-rubber Compound, protected by a covering of Vulcanised Asbestos Sheeting, as shown above, and as it is the only Jointing Material which adequately combines PERMANENT ELASTICITY WITH HEAT RESISTANCE, the advantages it possesses will at once be seen.

The Centre from which the requisite elasticity is obtained will adapt itself to uneven surfaces to which it may be applied, and allow the expansion and contraction to be fully taken up. The covering being of Asbestos Cloth, imparts a protection to the centre and so prolongs its elasticity. For Manhole, Mudhole, Steam Pipe, and Mash Tun Door Joints it is unequalled, and if applied as directed a ring can be used many times over.

ASBESTOS
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BELL'S ASBESTOS.
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Will effectually keep Boilers clean and remove any Incrustation, without injury to the Boiler Plates or Fittings.

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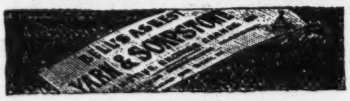

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BELL'S ASBESTOS. NON-CONDUCTING COMPOSITION.

Will reduce loss by radiation, and saves 40 per cent. of fuel.

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Is sent out dry in bags therefore cheaper than others sent out wet.

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BELL'S ASBESTOS
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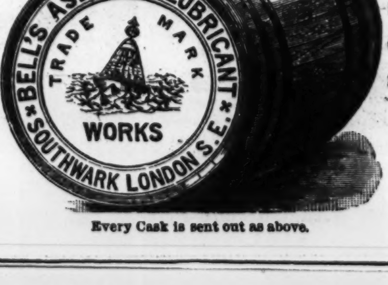
All bags are marked as above.

BELL'S ASBESTOS LUBRICANT.

BELL'S ASBESTOS LUBRICANT TRADE MARK

Any customer receiving Oil sold as Bell's Asbestos Lubricant, & Cask, Drum, or Corks not marked as shown, is earnestly requested to forward us sample and particulars of where obtained.



ASBESTOS BELL'S LUBRICANT

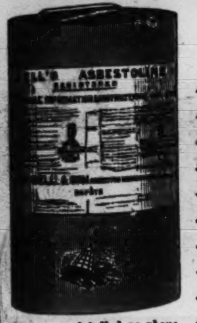
Drums are marked as above.

Every Cask is sent out as above.

All Corks are sealed as above.

BELL'S ASBESTOLINE.

REGISTERED.



All kegs are labelled as above.

ADVANTAGES OF ASBESTOLINE.

ASBESTOLINE is the most efficient Lubricant for all bearings.
ASBESTOLINE is the cheapest Lubricant.
ASBESTOLINE saves from 50 to 90 per cent. of the Cost of Oil.
ASBESTOLINE is the Cleanest Lubricant.
ASBESTOLINE is favoured by Insurance Companies.
ASBESTOLINE is the most Inodorous Lubricant.
ASBESTOLINE is the safest Lubricant, its flashing point being 700 F.
ASBESTOLINE has beaten all other Lubricants in making trials.
ASBESTOLINE is applicable in and out doors in every climate.
ASBESTOLINE requires no special application.

BELL'S ASBESTOS.

CONSISTENCY OF ASBESTOLINE.

ASBESTOLINE, to meet all circumstances, is made in four degrees of consistency, A, B, C, and CC.

ASBESTOLINE A. is specially adapted to ordinary Land Engines and Machinery, in and out-door, in this country.

ASBESTOLINE B, a little more solid, is for use on Steamships in temperate climates, also on land when it is desirable to have Lubricant stiffer than A.

ASBESTOLINE C, is for use in tropical climates, both ashore and afloat. It is also invaluable in works in this country when the temperature is high.

ASBESTOLINE CC, is designed for use on calenders, paper machines, &c., where the bearings are heated by steam passing through, and sometimes is advantageously used instead of C.

The reputation of Asbestoline as a lubricant of the highest efficiency in every kind of machinery is established, and it has never been equalled by any other lubricant in the numerous cases of special difficulty in which the best oils are ineffectual. This reputation is growing daily, because it is **based on the experience of thousands of users** under the severest circumstances any lubricant has ever been subjected to, **and not on mere laboratory tests** and professional analysis of insignificant quantities. It is used with marked success in Steel and Iron Works, Collieries, Cotton and Wool Mills, and other Textile Manufactories. In Corn Mills it has proved invaluable on the roller and other modern machines. In Saw Mills, on Machines going up to 5,000 revolutions per minute, its work has never been approached by any other lubricant. On Electric Lighting Machinery, and in Steamships of all sizes throughout the world, the success of Asbestoline is unequalled. Many engines and machines of all descriptions give trouble and show bad results, both in working and wear, when the system of lubrication has not received due consideration. Engineering firms of the highest standing have given to it their powerful testimony and support.

SUPPLIED IN KEGS, 28 lbs., 56 lbs., or 112 lbs.

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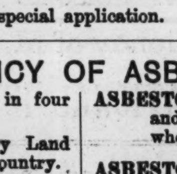
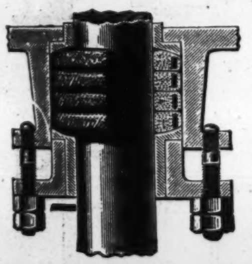
IMPORTANT TO EXPORT MERCHANTS.—One Pound of "Asbestoline" equals 2 gallons of Oil weighing 18 lbs. consequently the saving in freight is very considerable. Liberal Terms are conceded to Export Merchants.

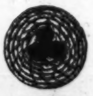
BELL'S ASBESTOS DAGGER PACKING



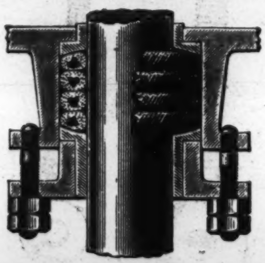
Patent.



SQUARE.



ROUND.



Every 10 feet has label as above, and bears our Trade Mark.

Under this registered title are included the inventions of Mr. Field, and experience has proved them to be **THE MOST EFFICIENT, DURABLE, AND ECONOMICAL PACKINGS** ever made. They constitute such a combination of Asbestos and India-rubber as secures the maximum of elasticity and heat resistance, and they are therefore **UNEQUALLED FOR EVERY KIND OF ENGINE.** These Packings are being universally used by most of the leading Steamship Companies throughout the world for ordinary Compound, Triple, and Quadruple Expansion Engines of the latest type. These Packings are composed of Rolled Asbestos Cloth, but the India-rubber is placed in two forms to suit various cases.

☞ **In ordering, state whether square or round required.** ☜

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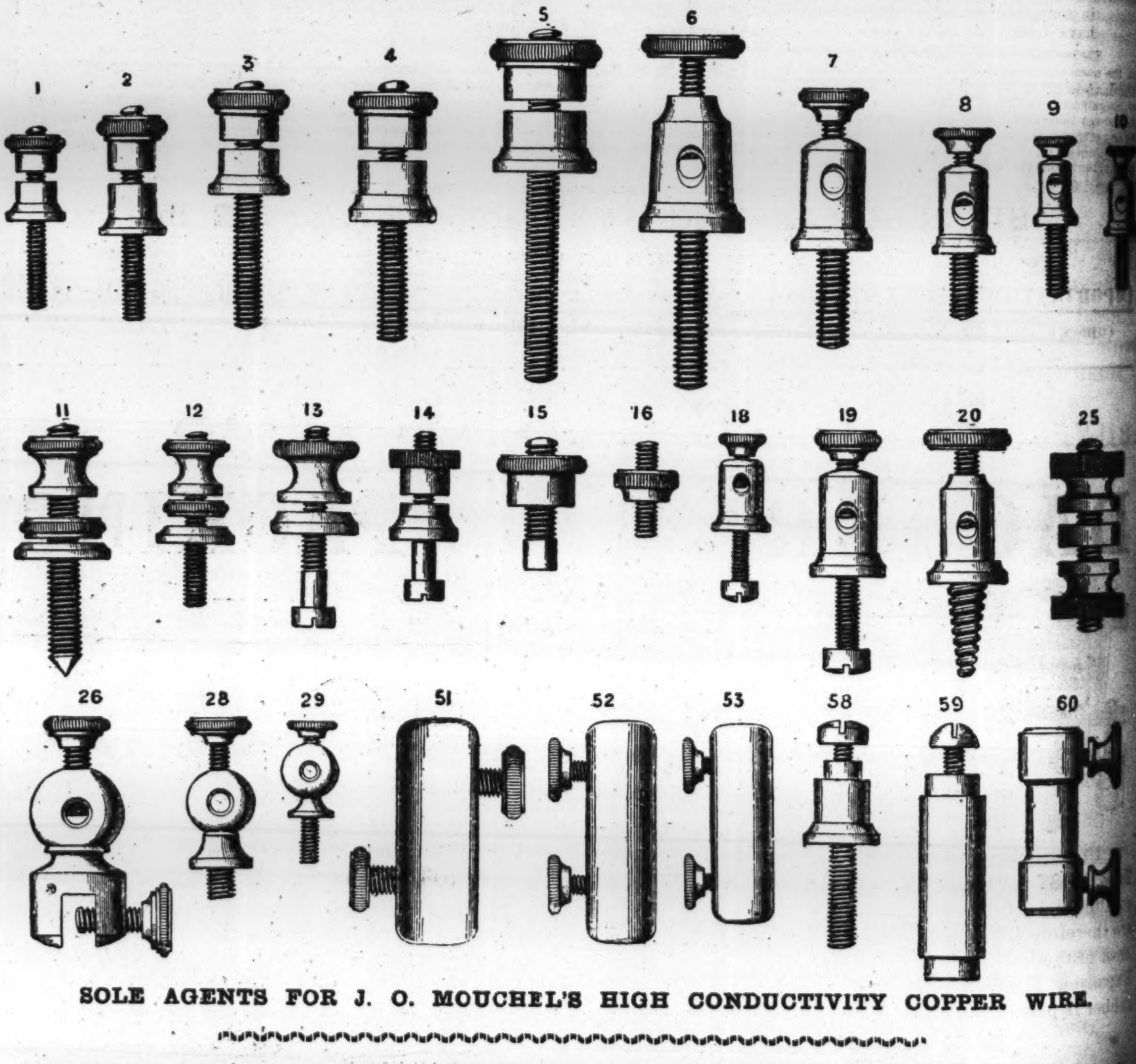

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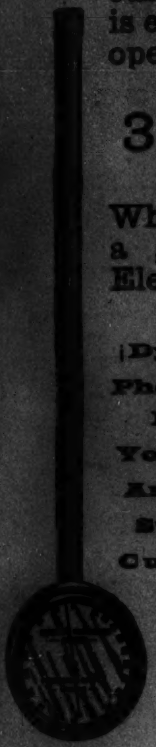

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Specially Wound Dynamos to charge cells and supply constant E.M.F. to Lamp Mains independently and at the same time.

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